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National Atmospheric Deposition Program/National Trends Network (NADP/NTN) Site Visitation Program

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Prepared for

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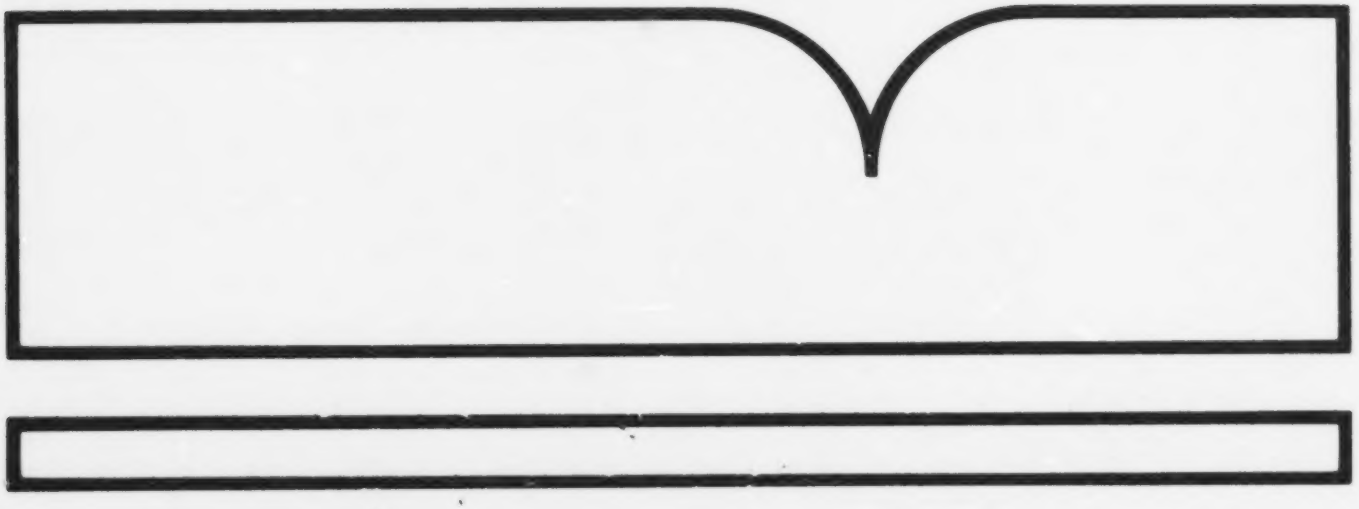

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16. ABSTRACT

Survey visits to the NADP/NTN precipitation collection stations are part of the network's quality assurance program and are coordinated through the NADP/NTN Quality Assurance Director's office. Research Triangle Institute, under contract to EPA, has visited approximately two-thirds of the 200 NADP/NTN sites for the purposes of verifying and documenting that pre-established siting criteria are met; assessing the uniformity of sample collection, analysis, and reporting procedures; conducting quality assurance tests of the operators' equipment and procedures, and providing technical assistance and instruction. Of the approximately 120 sites visited from October 1986 through the present, most are operating within specified guidelines. Variances such as out-of-calibration rain gauges, pH electrode response accuracy outside ± 0.1 pH unit tolerance, inoperative precipitation collector sensor heaters, and siting variations are summarized and compared to the findings from the first round of visits. Test methods and significant findings are summarized.

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THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM/ NATIONAL TRENDS NETWORK (NADP/NTN) SITE VISITATION PROGRAM

(October 1986 Through September 1987)

by

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ABSTRACT

The proper collection of precipitation and the accurate measurement of its constituents are important steps in attaining a better understanding of the distribution and effects of "acid rain" in the United States. One of NAPAP Task Group IV's major programs concerns wet deposition monitoring. One of that program's projects, 4A-15, "Quality Assurance Support for Wet Deposition Monitoring" is sponsored by EPA to evaluate the sample collection process of the NADP/NTN networks through a site visitation program. Research Triangle Institute, as contractor to EPA, conducts these visits. If deficiencies or nonstandard procedures are noted, the site operator and supervisor are notified. Brief reports are sent to the EPA Principal Investigator and the NADP/NTN Quality Assurance Manager. In this way, necessary changes can be made promptly.

All NADP/NTN sites were visited in 1985-1986. A second round of visits began in October 1986, with the goal of visiting approximately one-third of the 200 sites each year over the three-year span 1986-1989. This document is a summary report of the findings from the 1986-1987 (Fiscal Year 1987) site visitation program to 62 of the sites that comprise the National Atmospheric Deposition Program and National Trends Network precipitation networks, referred to collectively as the NADP/NTN network. In its present configuration, the NADP/NTN network's research and monitoring programs are supported and operated by the U.S. Geological Survey, State Agricultural Experiment Stations, the Departments of Agriculture, Interior, Commerce and Energy, and the Environmental Protection Agency. Additional support is provided by state agencies, public utilities, and industry.

Protocols and procedures followed in conducting the site visits are described. Results of systems and performance audits are discussed for siting, collection equipment, and the field support laboratories.

Where exceptions are found, the potential effects of nonstandard siting, improperly operating equipment, and improper sample handling or analysis technique on the data base are discussed. Recommendations are given for improvement and standardization of individual sites and the network as a whole.

This report was submitted in fulfillment of Task 231B of EPA Contract No. 68-02-4125 by Research Triangle Institute. This report covers site visits made during the period October 1, 1986, through September 30, 1987, and all work was completed as of September 30, 1987.

ACKNOWLEDGEMENTS

The authors express appreciation to all participants in the NADP/NTN Precipitation Network (site operators, site supervisors, and agency coordinators) for their help in arranging for the site visits and their interest in the program. The assistance of personnel from the NADP/NTN Coordinator's Office (D.S. Bigelow and J.H. Gibson) and the Central Analytical Laboratory (S. Dossett) is also appreciated. The advice and encouragement of the EPA Project Officer, Berne I. Bennett, are also acknowledged.

SECTION 1
INTRODUCTION

This document is the summarizing report of quality assurance assistance and findings from site visits made to the National Atmospheric Deposition Program/ National Trends Network (NADP/NTN) precipitation collection stations in the period October 1986, through September 1987. Each site is located and operated according to protocols and procedures as given in the siting and operating manuals for the networks (1, 2, 3, and 4). The purposes of the site visitation program, sponsored by the U.S. Environmental Protection Agency, are to verify that each site is operating according to established procedures and to provide technical assistance as required.

Sixty-two of the 201 sites that were in operation as of June 30, 1987, were visited during this time frame. Table 1 lists the sites by name, their identification numbers, the names of each site's supervisor and operator, and the date of the site visit. Figure 1 shows the NADP/NTN site locations.

GOALS

The goals of the site visitation program for quality assurance assistance to the NADP/NTN collection sites are to:

(1) Provide a qualitative assessment of each site and its surroundings, the operator's adherence to sample collection and analysis procedures, and the condition of the site's collection and analysis equipment through an on-site systems survey;

(2) Provide a quantitative assessment of the operation of the precipitation collector and the accuracy of response of field and laboratory measurement devices for precipitation depth, mass, temperature, conductivity, and pH through an on-site performance survey;

(3) Provide technical assistance to the operator by verbal explanation, minor troubleshooting, repair and calibration of equipment, and by making recommendations for sources of corrective action;

(4) Prepare brief reports for each site detailing site characteristics, results of quality assurance tests, and technical assistance provided. Submit the reports to the NADP/ NTN Quality Assurance Manager, the Central Analytical Laboratory's Site Liaison, and the EPA Project Officer;

TABLE 1. NADP SITES VISITED IN FY 87

Site Name	ID	Supervisor	Operator	Date of Site Visit
Sand Mountain	011020	Charles Jenkins	James Burns	12/08/86
Niwot Saddle	060220	Mark Noble	Mark Losleben	08/06/87
Sugarloaf	060221	Mark Noble	Mark Losleben	08/06/87
Buffalo Pass-Summit Lake	061920	Jimmy Dickerson	Rich King	08/04/87
Buffalo Pass - Dry Lake	061921	Jimmy Dickerson	Rich King	08/04/87
Engineer Mountain	061980	Douglas Fox	Mark Story	08/13/87
Molas Pass	061981	Douglas Fox	Mark Story	08/13/87
Bradford Forest	100360	Hans Riekerk	Larry Korhnak	02/25/87
Kennedy Space Center	100380	William Knot	Tom Dreschel	02/26/87
Everglades National Park	101190	Dan Scheidt	George Schardt	03/02/87
Quincy	101400	Marvin Franklin	Jerilyn Collins	02/24/87
Verna Well Field	104100	Terrie Lee	Curtis Beavers	02/27/87
Bellville	112040	J. L. Rakestraw	J. M. Rogers	02/26/87
Georgia Station	114140	Dr. Jerry Walker	John Melin	02/24/87
Tifton ARS	115000	Gary Buell	Homer Allison	02/25/87
Headquarters	130480	Paul Hart	Nolan Cochrell	05/14/87
Reynolds Creek	131180	Ross Wight	Jim Mowbray	05/12/87
Shabbona	141800	Dr. Gary Rolfe	Dave Lindgren	04/13/87
Argonne	141980	Marvin Wesely	Doug Sisterson	04/14/87
Huntington Reservoir	152020	Cheryl Silcox	Gary Zeissig	04/16/87
Indiana Dunes	153420	Louis Brenan	Louis Brenan	04/15/87
Purdue	154100	Dr. Rich Grant	Mickey Patterson	04/17/87
Lilley Cornett Woods	182260	Mike Brotzge	Robert Watts	12/15/86
Acadia National Park	200011	Leighton Carver	Carroll Schell	07/24/87
Caribou	200045	Richard Artz	John Chiaramonte	07/20/87
Presque Isle	200046	Richard Artz	Joe Lloyd	07/21/87
Bridgeton	200277	Leighton Carver	Peter Lowell	07/23/87
Greenville	200935	Dr. Ivan Fernandez	Llew Wortman	07/22/87
Marcell Exp. Forest	241660	Elon S. Verry	Arthur E. Elling	07/29/87
Fernberg	241840	Robert Berrisford	Christine Barton	07/27/87
Camp Ripley	242360	Mark Have	Mary McGuire	07/25/87
Clinton	251080	Paul Grantham	William Morris	12/11/86
Meridian	251460	Richard Artz	Daniel Mondella	12/11/86
Coffeeville	253000	Paul Grantham	Hillard Griffin	12/10/86
Lewiston	340320	Dr. Robert Bruck	Steve Herlocker	12/09/86

TABLE 1 (cont). NADP SITES VISITED IN FY 87

Site Name	ID	Supervisor	Operator	Date of Site Visit
Coweeta	342500	Wayne Swank	Bob McCullum	12/18/86
Alsea Guard Station	380200	Robert T. Lackey	Danny Rambo	06/20/87
Hyslop Farm	380202	Robert T. Lackey	Danny Rambo	06/21/87
Bull Run	380260	Julija Laenen	Alberta Seierstad	06/19/87
Silver Lake	380980	Julija Laenen	Charlie Plumb	06/23/87
Andrews Exp. Forest	381020	Arthur McKee	John Moreau	06/22/87
Vines Hill	381120	Ralph Heft	Jerry Bourasa	05/19/87
Starkey Exp. Forest	381800	Julija Laenen	Scott Feltis	05/15/87
Santee NWR	420680	Richard Hayes	Ron McGonicle	02/27/87
Walker Branch	440040	Steve Lindberg	Jim Owen	12/16/86
Giles County	441140	Charles Jenkins	Gene Morris	12/09/86
Elkmont	441190	John Peine	David Silsbee	12/17/86
Beeville	450350	Richard Artz	Candy Moore	01/23/87
Attwater Prairie Chicken	451060	R Goss/T Prussa	Bob Adamcik	01/21/87
Longview	452180	Dick Leard	Roddy Sloan	01/26/87
Forest Seed Center	453800	Mike Guski	Beverly Peoples	01/27/87
Victoria	455350	Richard Artz	Charlie Mabe	01/22/87
Horton's Station	481300	Bill Winner	Chris Gillespie	12/12/86
Big Meadows	482890	David Haskell	Rob Yates	12/11/86
Sullivan Lake	491540	Bill Ehinger	Keith Fletcher	05/18/87
Popple River	510960	Bruce Rodger	Jim Trochta	06/19/87
Suring	512500	Bruce Rodger	Jim Trochta	06/17/87
Trout Lake	513640	Bruce Rodger	Joan Elias	06/18/87
Lake Geneva	513680	Bruce Rodger	Ted Peters	06/16/87
Spooner	513700	Bruce Rodger	Jill Plath	07/24/87
Snowy Range-Glacier Lake	520020	Frank Sanders	Jim Sherman	08/10/87
Snowy Range - Nash Fork	520021	Frank Sanders	Jim Sherman	08/11/87

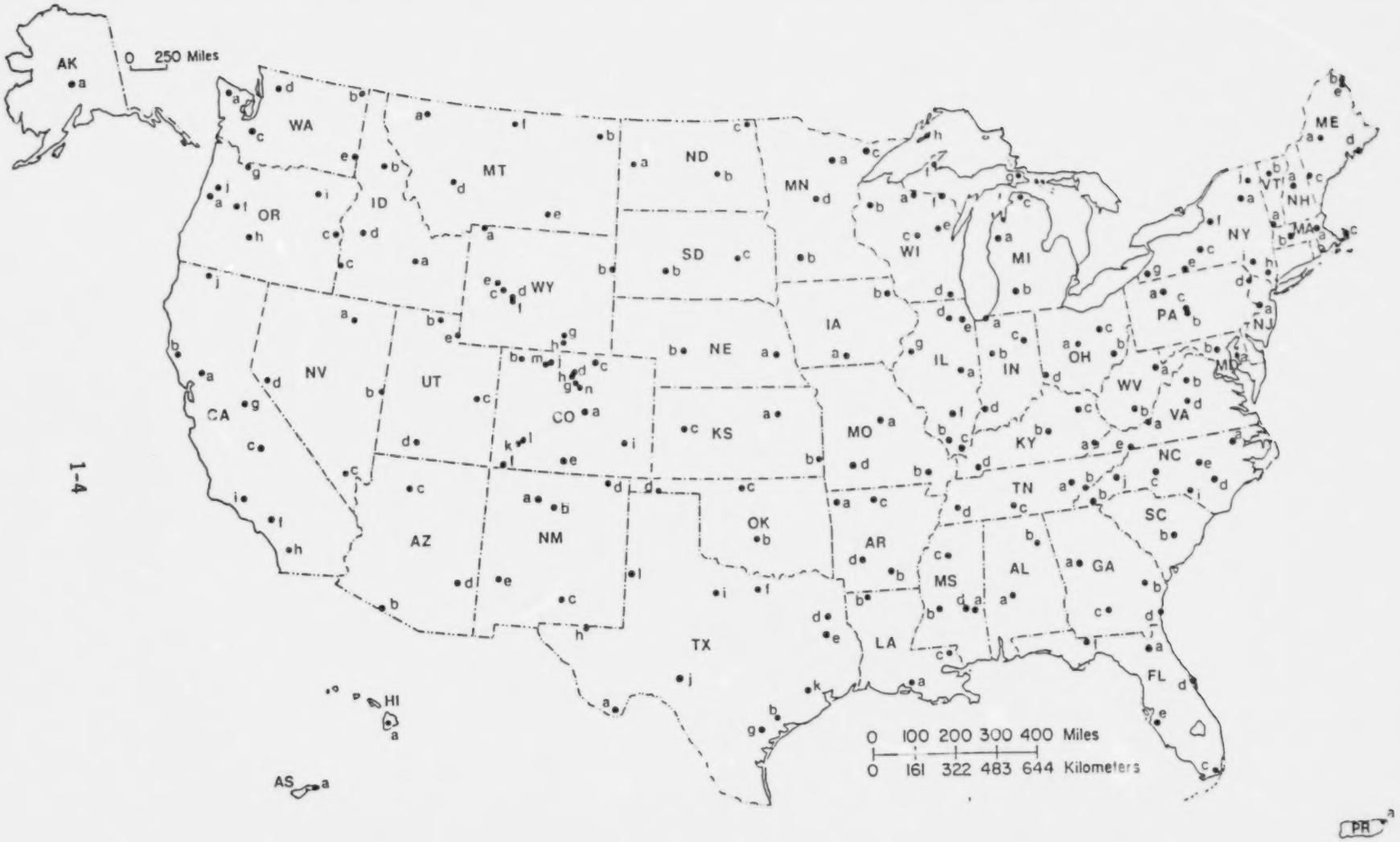

Figure 1. Active Sites in the NADP/NTN Monitoring Network as of June 1987.

(5) Computerize results of all information gathered from each site and submit this to the NADP/NTN Quality Assurance Manager on a quarterly basis;

(6) Document the sites and their surroundings by assembling a collection of site maps and color photographs.

This report is divided into eight sections. They are:

Section	Topic
1	Introduction
2	Conclusions
3	Recommendations
4	Approach
5	Protocols and Procedures for Collection Site Visits
6	Site and Field Laboratory Results and Discussion - Siting Survey - Field Laboratory Survey - Comparison to 1985-1986 Results
7	Comparison of 1987 and 1985-1986 Site Visitation Results
8	References

SECTION 2
CONCLUSIONS

Sixty-two NADP/NTN precipitation collection sites were visited over the one year period, October 1986, through September 1987. About one-third of the sites were visited during this first year of a three-year schedule. The sites are located in all regions of the country and are sponsored and operated by numerous agencies. Each operates according to standard operating procedures and is located according to siting criteria. This report assesses the degree to which procedures and criteria are adhered to; predicts, where possible, the relative impact on the data which might be expected from the variances found; and compared results from this second round of visits to those documented in the first round of visits that occurred over the period December 1984, through September 1986.

SITING

Improvements in adherence to siting criteria were noted at most of the sites visited in 1987 as compared to observations from the first round of visits in 1985-1986. A number of sites had separated the collector and rain gauge to the prescribed 5 meter distance and had oriented the collector's wet-side bucket to the west. Obstructions and sources of dust such as animals, parking lots, and chemical storage areas had been removed.

For the thirteen siting criteria summarized in this report (refer to Table 4), 44 of 61 sites (72%) had at least one variance. Eighteen percent of the sites had 3 or more variances. Most of the variances, due to the nature of certain criteria and/or the degree to which the criteria were exceeded, are expected to have minimal effects on the data base. For example, network siting criteria require that the precipitation collector and rain gauge be separated by at least 5 m and no more than 30 m. Twenty percent of the sites failed to meet this criterion, always because of inadequate separation. It is not likely that the effect is measurable in the precipitation chemistry or catch efficiency as compared to a site that meets the criterion. Variances concerning collector height, use of platforms, wet bucket orientation, ground slope, enclosed collector bases, collector-gauge separation, collector-gauge heights, and vegetation higher than two feet, account for many of the variances and probably have little

effect on the data. The remainder of the variances are due to the presence of obstructions or potential pollutant sources of various types near the sites. For instance, 6 of 62 sites had obstructions near the collector that violated the 45 degree rule (i.e., the top of the obstruction should not be higher than 45° as measured from the collector). Ten sites had storage or lots within 100 m of the collector, 5 sites allowed animals to move closer than 30 m to the collector, and 6 sites had transportation sources within 100 m of the collector.

It is felt that variances such as these may have measurable effects on the data but because the type, magnitude, and proximity of the obstructions and sources vary widely from site to site, a measure of the effects is not possible from the data gathered in this site visitation program.

SAMPLE COLLECTION

Designated sample collection procedures are adhered to at almost all the sites in the network. All operators are careful not to touch the inside of the collection bucket or lid or contaminate the sample in anyway. All site operators stated that they checked the sample for contaminants (leaves, bird droppings, etc.) at the time of the bucket's removal from the collector. This procedure was not being well adhered to at the time of the first round of visits.

To ensure accurate precipitation data, it is most important that the precipitation collector and rain gauge are properly working and well-maintained. A properly working precipitation collector should uncover the wet bucket at the beginning of a precipitation event, recover the wet bucket shortly after the event stops, and keep dust, etc. out of the wet bucket when there is no precipitation. There were indications at 14 of 60 sites (23% of the total) that the Aerochem Metrics precipitation collector's clutch was wearing and at 3 of 58 sites that the sensor was not operating properly. Thirty-two percent of the rain gauges were found to be out of calibration by more than $\pm$ 0.1 inch at some point on the 0-12 inch scale. It is believed this will not be a major source of error since the calibration errors usually occurred at a depth of 5 inches or more and the operator is instructed to empty the catch bucket before this depth is reached.

FIELD LABORATORY PROCEDURES

Field laboratory procedures for sample handling, conductivity measurements, and pH determinations were being carried out properly and accurately in almost all cases. Proper procedures were discussed or demonstrated to site operators as needed.

Results were improved over those noted at the time of the first round of visits. For example, only two sites were unable to determine the pH to within $\pm$ 0.1 unit of the designated value. All twelve of the sites that were outside of tolerance for pH measurements in Round 1 of the site visits were within tolerance in Round 2. Overall, 97 percent of the 60 field laboratories checked in 1987 agreed within $\pm$ 0.1 pH unit with the audit solution's designated value.

Results were similar for conductivity measurements. Sixty of sixty-two sites (97%) determined the audit solution's conductivity to within $\pm$ 4 μS/cm of the designated value.

The solution balances were operating properly in all but one case. This problem was traced to binding of the damper bar in the magnetic dampening assembly. This was corrected. Of fifty-eight balances checked, the absolute average difference was 2.2 g, usually occurring at the maximum loading, and corresponding to a difference of less that 0.1 percent at an average test weight load of 3736 grams.

SECTION 3
RECOMMENDATIONS

The site precipitation collector and rain gauge are central to the successful operation of the network. Based on several problems noted with collector operation and rain gauge calibration, it is recommended that site operators be reminded from time-to-time of the importance of weekly equipment checks. There were increased incidences of clutch wear. Thus, the collector clutch assembly inspection should be added to the operator's inspection list. The failure of the precipitation collector's sensor heaters has greatly diminished. A simple check of the collector's sensor heater by activating the collector with water and, after five minutes, lightly touching the sensor surface to verify it is heating, should continue.

Rain gauges continue to be out of calibration, although most of those calibrated in 1985-1986 have remained in calibration. It is again recommended that a simple, on-site calibration check of the rain gauge be instituted and carried out every six months with a copy of the gauge chart used for the check forwarded to CAL for review.

Recommendations for improving site locations center around those siting criteria that, if violated, may affect the catch efficiency or chemistry of the precipitation samples. Specifically, it is recommended that the NADP/NTN Coordination Office take the following steps to correct conditions at several sites.

- Relocate the collector or remove the obstruction (tree, etc.) that causes the 45° angle rule to be violated (six sites).
- Relocate the collector or restrict use of nearby parking lots and storage facilities so that a 100 m separation is achieved (ten sites).
- Relocate the collector or install fencing so that animals are kept at least 30 m away (five sites).
- Relocate the collector so that transportation roadways and sources are kept at least 100 m away (six sites).
- Install platforms at those sites in snowy regions that may benefit from the extra height above the snow pack level (three sites).
- Reorient the collectors whose wet-side collection bucket faces north or east so that they face west (eight sites).

- Remove the enclosures from the base of collectors to eliminate concern over turbulence in the vicinity (five sites).
- Where expedient and inexpensive to do so, relocate collectors or rain gauges so that a minimum separation distance of 5 m is achieved (twelve sites).
- Emphasize to site operators and supervisors that grass, weeds, and small trees or bushes should be kept at a height of 2 feet or less in a circle with a radius of 30 m from the collector.
- Level any collectors or rain gauges that are out-of-tolerance (five sites).
- Investigate whether or not the resistivity required to activate the collector sensor should be set closer to the factory value of 80 Kohm for several of the collectors.
- Supply rain gauge dampening fluid (silicone oil) to those sites that may need to fill reservoirs to within 0.25 inch of the top.

The quality assurance information provided by these site visits is only a portion of the total available. It represents only a "snapshot" of the total monitoring period. The site visit information may be merged with other site and CAL-acquired information to allow a more comprehensive evaluation of the effect of variations on the total data base. For instance, it was found that the collector's sensor was not heating at some sites. Other sources of information may be used to deduce over what period it was malfunctioning (a careful examination of the opening/closing cycles as shown on the recording rain gauge chart; review of site logbook to note repair data).

SECTION 4
APPROACH

The following five-step approach was utilized in preparing for and conducting visits to precipitation collection sites in the NADP/NTN network.

DOCUMENT REVIEW AND PREPARATION OF A SITE VISITATION QUESTIONNAIRE

The latest network documents and reports (1, 2, 3, 4, and 5) were reviewed and, based on their contents, work plans and questionnaires (6) were prepared that are specific to the operation of the NADP/NTN network were updated. The questionnaire was used to conduct systems and performance surveys of the site and field laboratory operations and to assess the operator's adherence to designated procedures.

SITE VISITOR TRAINING SESSIONS

All RTI site visitors have attended and participated in an instructional course for NADP/NTN site operators. These courses were held at the Illinois State Water Survey Laboratory in Champaign, Illinois, the contractor for the network's Central Analytical Laboratory. Information on quality control results was obtained and the CAL-operated site (Bondville, IL) was visited. These training sessions gave members of the site visitation team the opportunity to meet site operators in advance of the visits and to learn what is expected of a site operator.

During the first of several visits to local sites, two or more members of the site visitation team were present. An "idea and techniques" sharing session followed the visit so that on future trips each visitor would employ a similar routine, answer questions, and give technical assistance in a uniform manner.

ESTABLISH CONTACT WITH PERSONNEL AND SPONSORS WHOSE SITES ARE TO BE VISITED

In coordination with the EPA Project Officer, contact was made by telephone and letter with those persons whose sites were to be visited. Both the site supervisor and operator were encouraged to be present. The data for the site visits were set, the itinerary planned, and information such as topographical maps were acquired and studied prior to the actual site visit.

VISIT AND EVALUATE SITES AND PROVIDE TECHNICAL ASSISTANCE

The sites and field laboratories were visited and evaluated. During the visit, the questionnaires were completed and each site was documented by sketch and photographs. The site's location was verified on a USGS 1:24,000 series map.

The second round of site visits began in October 1986, and is to continue through September 1989. In this first year (1986-1987) of the second round of visits, 62 of 201 active sites were visited.

REPORTING OF RESULTS

Five types of reports were used in the site visitation program. They are:

- Brief handwritten exit reports that are left at the site;
- Longer handwritten reports that are prepared upon return from the field;
- Annual reports to the NADP at the time of the annual technical review session;
- Computerized tapes and printouts containing all answers and comments recorded in the site visitation notebooks; and
- This annual summary report that is distributed by EPA.

Throughout the site visit, the site visitor verbally briefed the supervisor and operator on the results of the systems and performance survey. At the conclusion of the visit, a handwritten exit report was prepared and a copy was provided to them. Copies of the brief and longer reports of the survey results (including recommendations for corrective action) were mailed to the site liaison at CAL and to the NADP/NTN Quality Assurance (QA) Manager at the Coordinator's Office. Figure 2 illustrates the categories covered in the brief report.

Bound copies of the original notebooks containing the site survey results are kept on file at RTI. Copies of the notebooks, the photographs, and annotated maps are sent to the QA Manager's Office for study and archiving.

An annual report, consisting of a technical summary of the year's activities, was presented in a briefing to NADP/NTN at the time of the annual technical meeting. A poster session was presented at the October 1987 meeting in Minneapolis, Minnesota.

NADP/NTN SITE VISITATION PROGRAM
Brief Site Survey Report Form

RTI Proj. _____

12/86 (Rev. 0)

A. Site Information

1. Site Name _____
2. CAL Code _____
3. CSU Code _____
4. Supervisor's Name _____
5. Operator's Name _____
6. Operator address incorrect.
7. Date of visit _____ (m) _____ (d) _____ (y)
8. RTI Visitor's Name _____
9. RTI Notebook Number _____
10. Site location changed since last visit.
11. Regular operator not present.
12. Site supervisor not present.
13. Site sponsor _____
14. Other.

B. Siting Criteria

15. Collector on platform.
16. Wet bucket not west; sensor not north.
17. Ground cover, slope, or buffer zone.
18. Collector base is enclosed.
19. Objects >1 m high within 5 m.
20. Collector/gauge separation or height nonstandard.
21. Snow roof.
22. Vegetation higher than 2 feet.
23. 45° rule violated.
24. Storage or lots <100 m distant.
25. Animals or pasture <20 m. Feedlots <500 m.
26. Transportation sources <100 m.
27. Residential buildings outside 30° cone.
28. Industry <10 km distant (<20 km if upwind).
29. Site is urban influenced.
30. Other.

C. Equipment Summary

Aerochem Metrics Collector

44. Clutch tooth or collar worn.
47. Lid seal to wet bucket has gaps.
51. Sensor does not heat when activated.
58. Other.

Belfort Rain Gauge

69. Gauge calibration out >0.1" (0 to 5")
70. Crossover point off >0.1".
71. Gauge calibration out >0.1" (6 to 12")
76. Other.

D. Sample Collection Procedures

78. Incomplete sampler servicing.
82. Other.

E. Field Laboratory Summary

Audit Test Solution No. _____

Conductivity Measurements

90. D1 water > 10 μS/cm _____.
91. Check sample beyond 21.8 ± 3 μS/cm _____.
92. Site value, audit, _____ μS/cm.
93. Designated value, audit, _____ μS/cm.

pH Measurements

99. Check sample outside 4.30 ± 0.1 _____.
100. Site value, audit, _____ pH units.
101. Designated value, audit, _____ pH units.
103. Other.

F. Notes and Comments

Entry No.

_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

Figure 2. Form for Brief Report of Site Visits

Still another report is a computerized file of all questions/answers and comments from each of the site visitation program notebooks. These validated files are submitted to the Coordination Office at Colorado State University via electronic transfer. Selected information from these files is compiled in the tables and graphs of this annual summary report.

SECTION 5
PROTOCOLS AND PROCEDURES FOR COLLECTION SITE VISITS

SCHEDULING

For this second round, each NADP/NTN site was to be visited once in a three year period. About one-third of the 201 active sites were visited in the first year (1986-1987). Prior to the scheduling of site visits, RTI consulted with the NADP/NTN QA Manager and CAL site liaison to determine which sites, if any, should be seen on a priority basis. Visits were planned so that several sites in the same vicinity could be seen in the same trip.

The following sequence was followed when arranging a visit to a collection sites.

- About two months before the anticipated date of visit, RTI selects a set of sites in a location suitable for a trip lasting up to two weeks and sets a tentative schedule for visits. As many as eight sites may be visited in this time frame, depending on the proximity of the sites.

- The NADP/NTN QA Manager, the Central Analytical Laboratory (CAL) of the Illinois State Water Survey, and the sponsoring agency are notified by letter of the proposed visits. CAL supplies pertinent information to RTI concerning each site.

- Each site's supervisor is telephoned to set up the visit. Depending on the wishes of the site supervisor, the supervisor contacts the operator or RTI contacts the operator to confirm the date, time, and place of the visit. When the supervisor makes the arrangement, he contacts RTI prior to the planned visit to confirm or alter the initial plan.

- A form letter is sent to each site's supervisor and operator that confirms the date, time, and place of the visit. This letter also gives a brief agenda for the visit and an estimate of the time to set aside for the visit (usually 4 to 5 hours).

A flow chart of the activities carried out in preparation for, conduct of, and reporting of a site visit is given in Figure 3.

FLOWCHART FOR SITE VISITS

I. SELECT SITE FOR VISIT AND INITIAL COMMUNICATIONS

- Advise QA Manager, CAL, site sponsor of plans; request site information; receive go-ahead
- Contact site supervisor; site operator; sponsoring agency
- Send letter of confirmation to supervisor, operator, agency
- Advise EPA that trip plans are complete

II. PRE-TRIP PREPARATION

- Make travel arrangements (air, car, hotel)
- Prepare and test quality assurance materials
- Review site-specific quality control information (maps, QC test results, etc.)
- Check equipment and supplies
- Prepare site visit notebook

III. CONDUCT SITE VISIT

- Outline activities to supervisor and operator
- Assess site and surroundings (map, photographs, obstructions, sources)
- QA tests of precipitation collector and gauge
- Adjust or calibrate collection equipment as required
- Assess operator handling and transport of collection bucket
- QA tests of conductivity and pH meters, balance
- Examination of site records, rain gauge charts
- Answer questions; provide information
- Prepare short report; conduct exit interview

IV. REPORTING

- Short report prepared; left with supervisor or operator
- Copy of short and extended reports forwarded to NADP/NTN QA Manager, to CAL, and to EPA Project Officer
- Copy of site visit notebook sent to NADP/NTN QA Manager; file original
- Summary reports prepared monthly and annually
- Report presented to NADP/NTN committees twice annually

Figure 3. Flowchart for Site Visits.

PRE-TRIP PREPARATION

Prior to each trip to a set of collection sites, the following preparations were made: travel arrangements; preparation and testing of quality assurance equipment and materials; review of site-specific quality control information; packaging and double-check of all equipment and supplies; preparation of site survey notebooks.

Review of Site-Specific Quality Control Information

Information on individual collection sites was supplied to RTI by the NADP/NTN QA Manager's office and the CAL site liaison in advance of the survey trips so that site contacts could be established and special attention given to an individual site's needs.

This information, supplied in the form of a computer printout of site information, and through telephone conversations with the CAL site liaison, contained:

- The site supervisor's and operator's names, addresses, and telephone numbers
- A description of the site and surroundings
- A list of the equipment at the site
- Confidential information on the operator's performance
- The site description questionnaire

The above, along with information obtained during earlier site visits, was reviewed at RTI prior to visiting the collection site. Information of a confidential nature was not discussed with the site operator.

Preparation of Site Survey Notebooks

Notebooks were prepared for use at each site. Each set of notebooks contained information concerning the site (operator, location, etc.), a record of pre-trip confirmation of test solutions, balance weights, etc., and the site survey questionnaire. Each notebook was bound, numbered, and checked for accuracy before the site visit. Upon completion and review, the original notebook was filed at RTI using a document control system. One copy of the notebook was provided to the NADP/NTN QA Manager.

SITE SURVEY VISITS

RTI personnel (W.C. Eaton, C.E. Moore, R.W. Murdoch, R.C. Shores, or D.A. Ward) accompanied the supervisor and/or operator to each collection site and field laboratory with the dual aims of (1) documenting the site and its immediate surroundings, its operation, and the accuracy of its instruments' responses to various quality assurance tests; and (2) providing information, training, and instruction for operators and supervisors, equipment calibration and minor maintenance as needed, and establishing contacts for further information and/or major repairs. A general list of items checked is given in Table 2.

Systems Survey

A quality assurance systems survey was conducted at each site to qualitatively assess the site, its surroundings, and the operator's adherence to procedures specified in the NTN design document (1) and in the NADP/NTN site operator's instruction manual (3). Criteria for siting an NADP/NTN precipitation station are illustrated in Figure 4. The operator was asked to demonstrate sample collection and analysis procedures. These were observed with special attention given to calibration procedures and sample handling technique. Site equipment was examined for signs of wear or faulty operation. It was noted whether solutions and equipment were properly stored. Site logbooks and rain gauge charts (if present) were examined for legibility, completeness, and accuracy.

Information from the systems survey was entered in the systems survey questionnaire. Photographs (color slides) of the sites were taken. The directions N, E, S, and W were photographed with the precipitation collector in the foreground. Additional views were taken as specified in the questionnaire.

Performance Survey

A quantitative performance survey was conducted at each site. Table 3 lists the equipment that was checked for performance and the type of test used. Criteria for evaluating performance are specified in the NADP Quality Assurance Plan (2). All information was recorded in the performance survey questionnaire. Several items having to do with quality assurance test equipment, materials, and procedures are discussed below.

TABLE 2. LIST OF ITEMS CHECKED DURING SITE SURVEY VISIT

Precipitation Sampler

- lid/bucket seal
- absence of gaps
- sensor heater operation
- clutch tension
- clutch wear
- winter problems
- proper counterbalance
- contamination by straps, wires
- snow roof design, material, orientation
- levelness and stability
- lid tension or drop
- bucket/sample handling
- orientation, height
- distance from other equipment

Supplies

- check inventory
- shortage of buckets
- excess buckets

Mass

- accuracy of response
- calibration weight handling
- tolerance checks
- correct use of balance

Precipitation Gauge

- winterization
- accuracy of calibration (weight response)
- cleanliness
- time calibration
- event marker operation
- ability to read chart correctly
- distance from other equipment
- height
- levelness and stability

pH Meter and Use

- accuracy of response
- no electrodes in bucket
- $\pm$ 0.1 pH unit agreement with test solution
- electrode condition
- electrode brand
- order of use
- use of pH check solution
- storage of buffers, check solutions

Conductivity

- accuracy of response
- no electrode in bucket
- use of standards

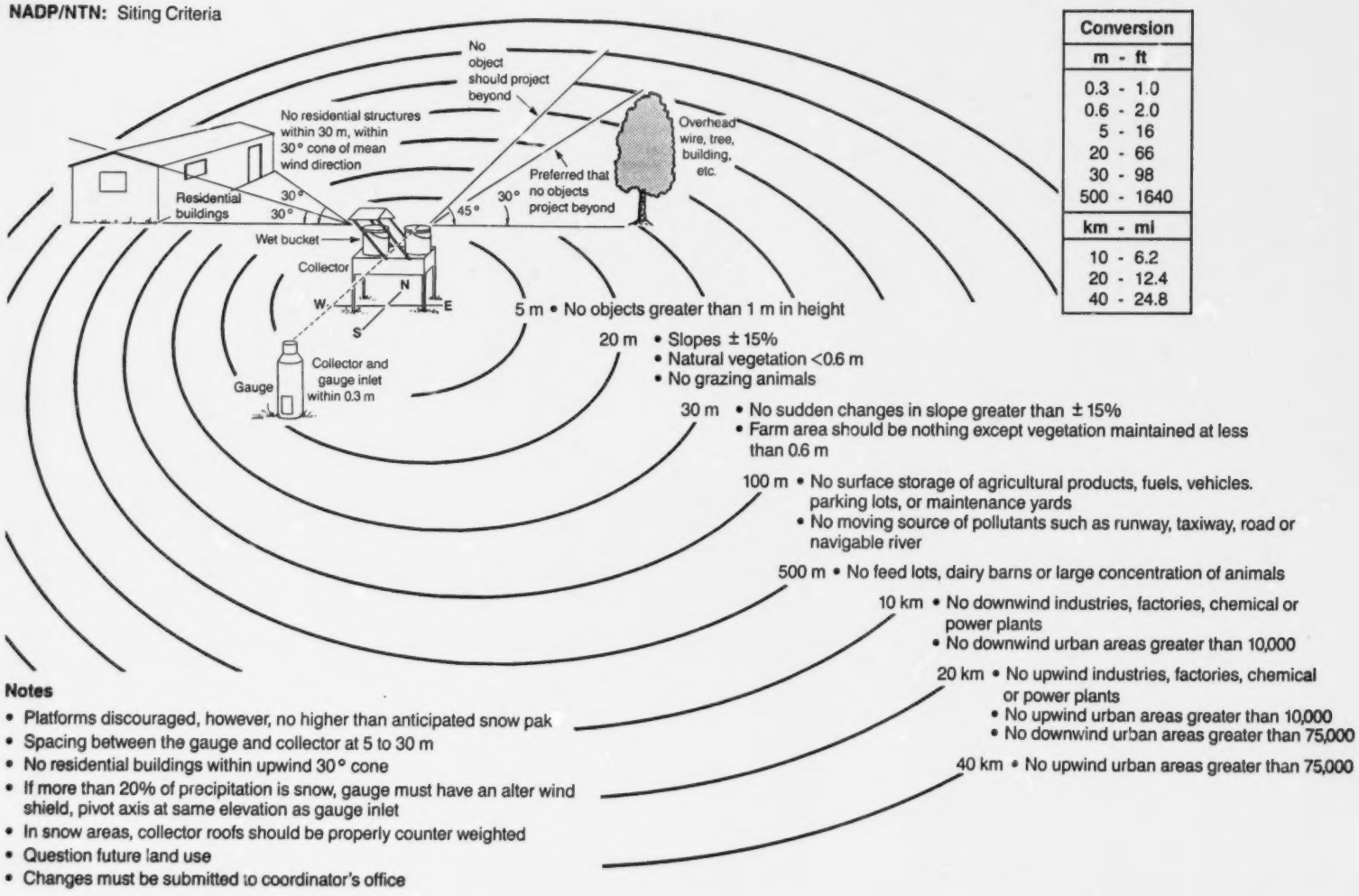
NADP/NTN: Siting Criteria
No object should project beyond
No residential structures within 30 m, within 30° cone of mean wind direction
Overhead wire, tree, building, etc.
Preferred that no objects project beyond
Residential buildings
30°
30°
45°
30°
Wet bucket
Collector
N
W
E
S
Gauge
Collector and gauge inlet within 0.3 m
5 m • No objects greater than 1 m in height
20 m • Slopes ± 15%
• Natural vegetation <0.6 m
• No grazing animals
30 m • No sudden changes in slope greater than ± 15%
• Farm area should be nothing except vegetation maintained at less than 0.6 m
100 m • No surface storage of agricultural products, fuels, vehicles, parking lots, or maintenance yards
• No moving source of pollutants such as runway, taxiway, road or navigable river
500 m • No feed lots, dairy barns or large concentration of animals
10 km • No downwind industries, factories, chemical or power plants
• No downwind urban areas greater than 10,000
20 km • No upwind industries, factories, chemical or power plants
• No upwind urban areas greater than 10,000
• No downwind urban areas greater than 75,000
40 km • No upwind urban areas greater than 75,000
Notes
• Platforms discouraged, however, no higher than anticipated snow pak
• Spacing between the gauge and collector at 5 to 30 m
• No residential buildings within upwind 30° cone
• If more than 20% of precipitation is snow, gauge must have an alter wind shield, pivot axis at same elevation as gauge inlet
• In snow areas, collector roofs should be properly counter weighted
• Question future land use
• Changes must be submitted to coordinator's office
Conversion
m - ft
0.3 - 1.0
0.6 - 2.0
5 - 16
20 - 66
30 - 98
500 - 1640
km - mi
10 - 6.2
20 - 12.4
40 - 24.8

Figure 4. NADP/NTN Siting Criteria Diagram.

TABLE 3. NADP/NTN SITE MEASUREMENTS AND PERFORMANCE SURVEY METHODS

Site Measurement	Measurement Device	Performance Survey Method	Designated Performance Criteria
Rain depth	Rain gauge (Belfort)	Challenge with known weights that simulate rainfall.	Agreement within ± 0.1 inch of test weight value over the range 0-12 inches.
Precipitation sample collection	Precipitation collector (Aerochem Metrics)	Measure resistance across sensor, measure tension and drop of bucket lid, measure temperature and resistance of activated sensor.	Resistance in range of 60-90 Kohms. Lid drop distance > 3 mm. Sensor temperature ambient prior to activation; temperature of 50-70°C after activation.
Mass	Triple beam balance	Challenge with traceable weights.	Agreement within ± 5 g of test weight value.
pH	pH meter and electrode	Challenge with simulated precipitation sample of known pH.	Agreement within ± 0.1 pH unit of test solution's designated value.
Conductivity	Conductivity meter and cell	Challenge with simulated precipitation sample of known conductivity.	Agreement within ± 4 µS/cm of test solution's designated value.

Precipitation Depth

The calibration of the Belfort recording rain gauge was checked over the range 0 to 12 inches by use of the certified weight set (Number 8849 6P-1) obtained from Belfort Instrument Company. The accuracy of the weight set was verified by periodically reweighing the weights versus NBS- or IOLM-traceable standards. To conduct the test, the operator removed the chart from the gauge and replaced it with a new one. Proper alignment of the chart on the drum was verified by the operator and the site visitor. Next, the zero reading was established and then a series of weights were placed on the gauge to simulate precipitation in one inch increments from 1 to 12 inches (in very dry areas only the range 0 to 6 inches may be checked). Gauge response was recorded in the notebook and on the chart.

If any one reading was more than $\pm$ 0.10 inch from the designated value, the gauge was calibrated (weather permitting) using the procedure given in the gauge manual (7).

One agency (NOAA) has its own program of precipitation gauge calibrations. If a NOAA-sponsored rain gauge was found to be outside the tolerance ($\pm$ 0.10 inch), the site supervisor was notified; no calibration was performed by the site visitation team.

Precipitation Collector

Several aspects of the Aerochem Metrics precipitation collector were checked. Information and check procedures are given in the collector's maintenance manual (8).

Mechanical. The proper opening and closing cycle of the collector was checked by applying deionized water to the sensor and watching and timing the open-close cycle. Wear on the thrust collar indent and thrust tooth was visually checked. Clutch pressure was checked by the mechanism's ability to lift 1640 g (two Belfort calibrations weights).

Tension on lid. Lid tension was checked in two ways: lifting the lid slightly with a spring scale and noting the force required; measuring the distance between the collector table top and the bottom edge of the lid with and without the collection bucket in place and noting the difference.

Sensor. The sensor's cleanliness, proper voltage, output to the event marker, electrical resistance at which the lid displaces, and heating (measured by a thermocouple placed against the sensor plate) were checked.

Mass

The accuracy of mass determination of the collection bucket contents by the triple beam balance was checked by having the operator weigh several Belfort rain gauge weights which had been calibrated to ± 0.1 grams against IOLM-certified brass weights.

pH and Conductivity

The accuracies of pH and conductivity measurements were checked by having the site operator analyze a simulated precipitation sample. This sample was a dilute solution of one of the EPA/NBS simulated precipitation reference materials which have been in use as quality assurance materials for several years (9). The reference material was diluted per instructions and a portion checked at RTI before being taken to a collection site. The solutions were subject to recheck upon their return from a field trip. The test sample was not placed in a collection bucket, but rather was given to the operator to add to the test vessels.

Technical Assistance

Technical assistance in the form of instruction, explanation, or demonstration was provided as needed to improve site performance. This assistance often included a discussion or demonstration of proper analytical techniques, instrument use, and calibration procedures. Operator questions were answered or referred to appropriate program personnel.

Whenever an equipment deficiency was found at the site, the problem was identified, corrective action recommended (see maintenance subsection) and, as necessary, the operator and supervisor were referred to CAL for additional information and guidance.

Maintenance

Minor maintenance was performed at NADP/NTN sites in an effort to improve site performance. The level of maintenance provided was limited by the amount of time required to complete a particular task, and the amount of equipment which could be hand-carried to the field.

Exit Interview

At the conclusion of the site survey, a short report of the visit was written and the results were discussed with the site operator and/or supervisor. During the exit interview, the operator and supervisor were given the opportunity to ask additional questions and express their feeling about the NADP/NTN program and their responsibilities within it.

SECTION 6
SITE AND FIELD LABORATORY SURVEYS
RESULTS AND DISCUSSIONS

SITE SURVEY

A total of sixty-two NADP/NTN sites were surveyed in fiscal year 1987. Each site is equipped with an Aerochem Metrics precipitation collector and a Belfort rain gauge. Specific procedures outlining the operation of this equipment for the collection of weekly precipitation samples are in place (3, 7, and 8). In addition, there are written siting criteria that specify minimum requirements each site should meet with regard to equipment placement, terrain, topography, and potential pollutant sources (1 and 4). Following are the results of qualitative system assessments made at each site with respect to NADP/NTN siting criteria and operational guidelines.

Siting Criteria Survey Results

Table 4 presents the results of assessments made at each site with respect to 13 siting criteria. The results of the findings are discussed below.

Collector Height Standard. The collector should be installed on its standard 1-meter-high aluminum base. Any of several methods can be used to stabilize or level the collector such as concrete pads or stakes. However, the bucket height of the collector should not vary from its standard height by more than $\pm$ 0.5 m. An exception to this criteria is permitted in areas with significant accumulations of snow. In this case, the collector may be placed on a platform that is no higher than the highest anticipated snow pack. To prevent obstructions to wind flow, the collector base should not be enclosed.

Eleven of sixty-two collectors checked (18%) were not at the standard 1 meter above ground height. Of these eleven, all were on platforms. All of these sites, with the possible exception of Georgia Station, were in areas where snow pack accumulates and warranted being on platforms. The base was enclosed on five collectors.

In most cases, platforms were short, not more than 2 to 4 feet in height. The higher platforms (Buffalo Pass and Snowy Range) were necessary to raise the collector above snow packs which could exceed 10 feet. The effect of shorter platforms on the sample is believed to be minimal.

TABLE 4, PAGE 1. SITING CRITERIA SURVEY RESULTS

Site Name	ID	Collector Height Standard	Collector on Platform	Wet Bucket Orientation	Ground Slope > 15
Sand Mountain	011020	Y	N	W	N
Niwot Saddle	060220	Y	N	N	N
Sugarloaf	060221	Y	N	W	Y
Buffalo Pass-Summit Lake	061920	N	Y	N	N
Buffalo Pass - Dry Lake	061921	N	Y	E	Y
Engineer Mountain	061980	N	N	W	N
Molas Pass	061981	N	Y	W	N
Bradford Forest	100360	Y	N	W	N
Kennedy Space Center	100380	Y	N	NE	N
Everglades National Park	101190	Y	N	S	N
Quincy	101400	Y	N	W	Y
Verna Well Field	104100	Y	N	W	N
Bellville	112040	Y	N	W	N
Georgia Station	114140	Y	Y	W	N
Tifton ARS	115000	Y	N	W	N
Headquarters	130480	N	Y	W	N
Reynolds Creek	131180	Y	N	N	N
Shabbona	141800	Y	N	W	N
Argonne	141980	Y	N	^	N
Huntington Reservoir	152020	N	Y	W	N
Indiana Dunes	153420	Y	N	W	N
Purdue	154100	Y	N	W	N
Lilley Cornett Woods	182260	Y	N	SSW	N
Acadia National Park	200011	Y	N	W	N
Caribou	200045	Y	N	E	N
Presque Isle	200046	Y	N	W	N
Bridgeton	200277	Y	N	W	N
Greenville	200935	Y	N	W	N
Marcell Exp. Forest	241660	Y	N	SSW	N
Fernberg	241840	Y	N	WNW	Y
Camp Ripley	242360	Y	N	SW	N
Clinton	251080	Y	N	W	N
Meridian	251460	Y	N	E	N
Coffeeville	253000	Y	N	W	N
Lewiston	340320	Y	N	SSW	N

TABLE 4, PAGE 1 (cont). SITING CRITERIA SURVEY RESULTS

Site Name	ID	Collector Height Standard	Collector on Platform	Wet Bucket Orientation	Ground Slope > 15
Coweeta	342500	Y	N	E	N
Alsea Guard Station	380200	Y	N	W	N
Hyslop Farm	380202	Y	N	W	N
Bull Run	380260	N	Y	W	N
Silver Lake	380980	Y	N	W	N
Andrews Exp. Forest	381020	N	Y	W	N
Vines Hill	381120	Y	N	W	N
Starkey Exp. Forest	381800	N	Y	W	N
Santee NWR	420680	Y	N	W	Y
Walker Branch	440040	Y	N	W	N
Giles County	441140	Y	N	W	N
Elkmont	441190	Y	N	W	N
Beeville	450350	Y	N	W	N
Attwater Prairie Chicken	451060	Y	N	NE	N
Longview	452180	Y	N	W	N
Forest Seed Center	453800	Y	N	W	N
Victoria	455350	Y	N	NW	N
Horton's Station	481300	Y	N	W	Y
Big Meadows	482890	Y	N	W	Y
Sullivan Lake	491540	Y	N	E	N
Popple River	510960	Y	N	W	N
Suring	512500	Y	N	W	N
Trout Lake	513640	Y	N	W	N
Lake Geneva	513680	Y	N	W	N
Spooner	513700	Y	N	W	N
Snowy Range-Glacier Lake	520020	N	Y	SW	N
Snowy Range - Nash Fork	520021	N	Y	WNW	N

TABLE 4, PAGE 2. SITING CRITERIA SURVEY RESULTS

Site Name	ID	Collector Base Open	Collector-Gauge Separation (m)	Collector-Gauge Heights OK
Sand Mountain	011020	Y	5	Y
Niwot Saddle	060220	N	30	Y
Sugarloaf	060221	Y	5	Y
Buffalo Pass-Summit Lake	061920	Y	1	N
Buffalo Pass - Dry Lake	061921	Y	5	Y
Engineer Mountain	061980	Y	5	Y
Molas Pass	061981	Y	6	Y
Bradford Forest	100360	Y	22	Y
Kennedy Space Center	100380	Y	5	Y
Everglades National Park	101190	N	7	Y
Quincy	101400	^	6	Y
Verna Well Field	104100	Y	6	Y
Bellville	112040	Y	6	Y
Georgia Station	114140	Y	5	Y
Tifton ARS	115000	Y	6	Y
Headquarters	130480	Y	6	Y
Reynolds Creek	131180	Y	16	Y
Shabbona	141800	Y	4	Y
Argonne	141980	^	^	^
Huntington Reservoir	152020	Y	10	Y
Indiana Dunes	153420	Y	3	N
Purdue	154100	Y	7	Y
Lilley Cornett Woods	182260	Y	5	Y
Acadia National Park	200011	Y	8	Y
Caribou	200045	Y	6	N
Presque Isle	200046	Y	6	Y
Bridgeton	200277	Y	5	Y
Greenville	200935	Y	6	Y
Marcell Exp. Forest	241660	N	5	Y
Fernberg	241840	N	5	Y
Camp Ripley	242360	Y	5	N
Clinton	251080	Y	4	Y
Meridian	251460	Y	17	N
Coffeeville	253000	Y	5	Y
Lewiston	340320	Y	5	Y

TABLE 4, PAGE 2 (cont). SITING CRITERIA SURVEY RESULTS

Site Name	ID	Collector Base Open	Collector-Gauge Separation (m)	Collector-Gauge Heights OK
Coweeta	342500	Y	5	Y
Alsea Guard Station	380200	Y	2	Y
Hyslop Farm	380202	Y	4	Y
Bull Run	380260	Y	5	Y
Silver Lake	380980	Y	5	Y
Andrews Exp. Forest	381020	Y	7	Y
Vines Hill	381120	N	1	N
Starkey Exp. Forest	381800	Y	7	Y
Santee NWR	420680	Y	5	Y
Walker Branch	440040	Y	2	Y
Giles County	441140	Y	5	Y
Elkmont	441190	Y	4	Y
Beeville	450350	Y	6	Y
Attwater Prairie Chicken	451060	Y	5	Y
Longview	452180	Y	6	N
Forest Seed Center	453800	Y	5	Y
Victoria	455350	Y	2	Y
Horton's Station	481300	Y	2	Y
Big Meadows	482890	Y	^	Y
Sullivan Lake	491540	Y	5	Y
Popple River	510960	Y	6	Y
Suring	512500	Y	6	Y
Trout Lake	513640	Y	6	Y
Lake Geneva	513680	Y	6	Y
Spooner	513700	Y	6	Y
Snowy Range-Glacier Lake	520020	Y	5	Y
Snowy Range - Nash Fork	520021	Y	6	Y

TABLE 4, PAGE 3. SITING CRITERIA SURVEY RESULTS

Site Name	ID	Vegetation > 2 ft High	45 degree Rule Violation	Storage or Lots < 100 m
Sand Mountain	011020	N	N	Y
Niwot Saddle	060220	N	N	N
Sugarloaf	060221	Y	N	N
Buffalo Pass-Summit Lake	061920	N	N	N
Buffalo Pass - Dry Lake	061921	N	N	N
Engineer Mountain	061980	Y	N	N
Molas Pass	061981	N	N	N
Bradford Forest	100360	Y	N	N
Kennedy Space Center	100380	N	N	Y
Everglades National Park	101190	N	N	N
Quincy	101400	N	N	N
Verna Well Field	104100	Y	N	N
Bellville	112040	N	N	N
Georgia Station	114140	N	N	N
Tifton ARS	115000	N	N	Y
Headquarters	130480	Y	N	N
Reynolds Creek	131180	N	N	N
Shabbona	141800	N	N	N
Argonne	141980	N	N	N
Huntington Reservoir	152020	N	N	N
Indiana Dunes	153420	N	N	N
Purdue	154100	N	N	N
Lilley Cornett Woods	182260	N	N	N
Acadia National Park	200011	N	N	Y
Caribou	200045	Y	N	Y
Presque Isle	200046	N	N	N
Bridgeton	200277	N	N	N
Greenville	200935	Y	N	Y
Marcell Exp. Forest	241660	N	Y	N
Fernberg	241840	Y	N	N
Camp Ripley	242360	Y	Y	N
Clinton	251080	N	N	N
Meridian	251460	N	Y	Y
Coffeeville	253000	N	Y	N
Lewiston	340320	N	N	N

TABLE 4, PAGE 3 (cont). SITING CRITERIA SURVEY RESULTS

Site Name	ID	Vegetation > 2 ft High	45 degree Rule Violation	Storage or Lots < 100 m
Coweeta	342500	N	N	N
Alsea Guard Station	380200	N	Y	Y
Hyslop Farm	380202	N	N	N
Bull Run	380260	N	N	N
Silver Lake	380980	N	N	N
Andrews Exp. Forest	381020	N	N	Y
Vines Hill	381120	Y	N	N
Starkey Exp. Forest	381800	N	N	N
Santee NWR	420680	Y	N	N
Walker Branch	440040	N	N	N
Giles County	441140	N	N	N
Elkmont	441190	Y	Y	N
Beeville	450350	N	N	N
Attwater Prairie Chicken	451060	N	N	N
Longview	452180	N	N	N
Forest Seed Center	453800	N	N	N
Victoria	455350	N	N	N
Horton's Station	481300	Y	N	N
Big Meadows	482890	Y	Y	N
Sullivan Lake	491540	Y	N	N
Popple River	510960	N	N	N
Suring	512500	N	N	N
Trout Lake	513640	N	N	N
Lake Geneva	513680	N	N	N
Spooner	513700	N	N	Y
Snowy Range-Glacier Lake	520020	N	N	N
Snowy Range - Nash Fork	520021	N	N	N

TABLE 4, PAGE 4. SITING CRITERIA SURVEY RESULTS

Site Name	ID	Animals < 30 m	Feedlots < 500 m	Transit Sources < 100 m
Sand Mountain	011020	N	N	Y
Niwot Saddle	060220	N	N	N
Sugarloaf	060221	N	N	N
Buffalo Pass-Summit Lake	061920	N	N	N
Buffalo Pass - Dry Lake	061921	N	N	N
Engineer Mountain	061980	Y	N	N
Molas Pass	061981	N	N	N
Bradford Forest	100360	N	N	N
Kennedy Space Center	100380	N	Y	N
Everglades National Park	101190	N	N	N
Quincy	101400	N	N	N
Verna Well Field	104100	N	N	N
Bellville	112040	N	N	N
Georgia Station	114140	N	N	N
Tifton ARS	115000	N	N	N
Headquarters	130480	N	N	N
Reynolds Creek	131180	N	N	N
Shabbona	141800	N	N	N
Argonne	141980	N	N	N
Huntington Reservoir	152020	N	N	N
Indiana Dunes	153420	N	N	N
Purdue	154100	N	N	N
Lilley Cornett Woods	182260	N	N	N
Acadia National Park	200011	N	N	N
Caribou	200045	N	N	Y
Presque Isle	200046	N	N	N
Bridgeton	200277	N	N	N
Greenville	200935	N	N	N
Marcell Exp. Forest	241660	N	N	N
Fernberg	241840	N	N	N
Camp Ripley	242360	N	N	Y
Clinton	251080	N	N	N
Meridian	251460	N	N	Y
Coffeeville	253000	N	N	N
Lewiston	340320	N	N	N

TABLE 4, PAGE 4 (cont). SITING CRITERIA SURVEY RESULTS

Site Name	ID	Animals < 30 m	Feedlots < 500 m	Transit Sources < 100 m
Coweeta	342500	N	N	N
Alsea Guard Station	380200	N	N	Y
Hyslop Farm	380202	N	N	N
Bull Run	380260	N	N	N
Silver Lake	380980	N	N	N
Andrews Exp. Forest	381020	N	N	N
Vines Hill	381120	Y	N	N
Starkey Exp. Forest	381800	Y	N	N
Santee NWR	420680	N	N	N
Walker Branch	440040	N	N	N
Giles County	441140	Y	N	N
Elkmont	441190	N	N	N
Beeville	450350	N	N	N
Attwater Prairie Chicken	451060	Y	N	N
Longview	452180	N	N	N
Forest Seed Center	453800	N	N	N
Victoria	455350	N	N	Y
Horton's Station	481300	N	N	N
Big Meadows	482890	N	N	N
Sullivan Lake	491540	N	N	N
Popple River	510960	N	N	N
Suring	512500	N	N	N
Trout Lake	513640	N	N	N
Lake Geneva	513680	N	N	N
Spooner	513700	N	N	N
Snowy Range-Glacier Lake	520020	N	N	N
Snowy Range - Nash Fork	520021	N	N	N

It was recommended that three sites (Caribou and Presque Isle, ME, and Engineer Mountain, WY) add platforms for their collectors. Snow pack is sufficiently high at these locations that a platform would be helpful.

Wet Bucket Orientation. The collector should be mounted with the wet-side bucket to the West and the sensor facing North. In this way, the wet-side bucket is generally upwind of the dry-side bucket (winds generally being from the S to SW in the eastern United States), and the sensor is downwind of the wet-side bucket. This placement is designed to lessen the chance for contamination and to minimize the obstruction of the collector itself to sample entry.

Of sixty-one sites examined in 1987, forty-seven (77%) were correctly installed with the wet bucket facing to the SW, W, or NW. Three were installed with the wet bucket facing SSW. These southerly installations probably have no effect on the data. Eight collectors that were installed with the collection bucket facing N or E may cause an aberration in the collection efficiency or sample chemistry. A statistical study of the long-term data base would be required to discern this and may be complicated by other factors. It is recommended that all collectors be oriented with the wet bucket facing West and the sensor facing North. The date this change occurs must be documented and accompany the data base.

Ground Slope. The collector should not be located on ground with a slope greater than 15 degrees or 27 percent. The slope at 7 of 62 sites (11% of the total) exceeded this criterion. Six of the seven sites were located in mountainous regions and were representative of their respective regions.

It is difficult to say what the effect of the steeper slopes is on collection efficiencies. However, to adhere too rigidly to the criterion would effectively eliminate many regions, especially those at higher elevations, from this network.

Collector Base Open. The base of the Aerochem Metrics collector should be open. Enclosing the base may cause turbulence in the vicinity of the collector and affect catch efficiency or cause sample contamination. Five of the sixty sites examined (8%) had the base enclosed. It was recommended that the enclosures be removed. They have become convenient storage locations in many cases.

Collector-Gauge Separation. The collector should be located within a distance of 30 m of the rain gauge but no closer that 5 m. This guideline is set so that the collector and gauge "see" the same precipitation event and so that neither piece of equipment offers an aerodynamic interference to the other's collection ability.

Twelve of sixty sites (20%) had rain gauges less than 5 m from the collector. The collector and rain gauge were mounted on a platform at several of these sites and separating them would require the construction of a second platform (one site had separate platforms). Some sites not meeting the distance requirements were enclosed by chain-link fences for security; meeting the distance requirements for these sites would require enlarging the enclosure or building a separate one. Many sites in this network may not be able to comply with this criterion due to cost. However, those gauges which can be removed to the proper distance should be and the move should be documented. None of the sites exceeded the recommended separation distance of 30 m. The narrowest separation was 0.5 m.

Collector and Rain Gauge at Same Height. The heights above ground of the collection bucket and the rain gauge orifice should be within 1 foot of each other. Seven of sixty-one sites (11%) did not meet this criterion. However, in all cases, the criterion was exceeded by small amounts and the effect on the data base is probably negligible.

Immediate Site Surroundings. Pages three and four of Table 4 give results related to the siting criteria for the area within a 500 m radius of the precipitation collector. The purpose of these criteria is to prevent sample contamination or obstruction from occurring. The presence of urban areas or industry at distances of 10 km or greater from the site is not considered in this report since this information has already been given in the report of the first round of site visits made in 1985-1986, and the site locations have not changed. Documentation of the presence of new sources after 1980 is not yet available as a NAPAP emissions inventory.

Vegetation within 30 m and the 45 Degree Rule -- Vegetation within 30 m of the collector should not be more than two feet tall and no object should project on the collector from an angle greater than 45 degrees. These criteria are intended to keep windblown contaminants such as seeds or splashing water out of the collection bucket and to prevent shadowing of the rain storm by tall objects.

Fourteen of sixty-two sites (23%) had vegetation of height greater than two feet within 30 m of the collector. Six sites (10%) had trees or meteorological towers too near the collectors that violated the 45° siting criterion. Under certain wind condition, it is possible that rain splashing from these objects into the collection bucket could significantly alter the sample chemistry.

Parking Lots, Chemical Storage -- The site should not be within 100 m of parking lots or chemical storage. Ten of sixty-two sites (16%) did not satisfy this criterion.

Grazing Animals or Feedlots -- The site should be more than 30 m from grazing animals and more than 500 m from large concentrations of animals such as feedlots, dairy farms, or poultry farms. These criteria are intended to ensure sources of compounds which could buffer acidic solutions are well away from the site. Five of the sixty-two sites examined in 1987 were affected only by grazing animals and the effect here is probably negligible since animals in these situations tend to roam over large areas and are not concentrated near the site. None of the sites, however, were near feedlots or other large concentrations of animals which could affect the sample chemistry.

Transit Sources Closer than 100 m -- Transit sources such as well traveled roads, railroads, and shipping channels should be no closer than 100 m to the sample collector. Five of sixty-one sites (8%) were judged to be too near such sources.

EQUIPMENT AND SAMPLE COLLECTION SURVEY

System and performance checks were made at each site to assess the operational fitness of the Aerochem Metrics precipitation collector and the Belfort rain gauge. The process of sample retrieval and care was also examined. These are discussed below.

Precipitation Collector System Checks

Given below is a discussion of precipitation collector systems checks. Refer to Table 5.

Power Type. Thirty-one of the sixty-two collectors are powered by AC current only. Fourteen (23%) have AC power and a trickle-charged battery back-up. Ten sites (16%) are powered by solar panels/battery. The most desirable AC arrangement is to use a trickle charged battery.

TABLE 5, PAGE 1. AEROCHEM METRICS COLLECTOR SYSTEM CHECKS

Site Name	ID	Power Type *	Collector Level	Collector Stable
Sand Mountain	011020	A	Y	Y
Niwot Saddle	060220	F	Y	Y
Sugarloaf	060221	E	Y	Y
Buffalo Pass-Summit Lake	061920	A	Y	Y
Buffalo Pass - Dry Lake	061921	E	Y	Y
Engineer Mountain	061980	A	Y	Y
Molas Pass	061981	E	Y	Y
Bradford Forest	100360	C	Y	Y
Kennedy Space Center	100380	A	Y	Y
Everglades National Park	101190	B	Y	Y
Quincy	101400	B	Y	Y
Verna Well Field	104100	A	Y	Y
Bellville	112040	C	Y	Y
Georgia Station	114140	B	Y	Y
Tifton ARS	115000	A	Y	Y
Headquarters	130480	B	Y	Y
Reynolds Creek	131180	A	Y	Y
Shabbona	141800	A	Y	Y
Argonne	141980	A	^	^
Huntington Reservoir	152020	A	Y	Y
Indiana Dunes	153420	A	Y	Y
Purdue	154100	A	Y	Y
Lilley Cornett Woods	182260	C	Y	Y
Acadia National Park	200011	A	N	Y
Caribou	200045	A	N	Y
Presque Isle	200046	A	Y	Y
Bridgeton	200277	A	Y	Y
Greenville	200935	A	Y	Y
Marcell Exp. Forest	241660	A	Y	Y
Fernberg	241840	B	Y	Y
Camp Ripley	242360	A	Y	Y
Clinton	251080	A	^	Y
Meridian	251460	A	Y	Y
Coffeeville	253000	A	Y	Y
Lewiston	340320	A	Y	Y

* (A) AC only; (B) AC w/ Aerochem trickle charger/battery; (C) Battery only; (D) Battery w/ external AC powered charger; (E) Solar; (F) Other.

TABLE 5, PAGE 1 (cont). AEROCHEM METRICS COLLECTOR SYSTEM CHECKS

Site Name	ID	Power Type *	Collector Level	Collector Stable
Coweeta	342500	B	Y	Y
Alsea Guard Station	380200	A	N	Y
Hyslop Farm	380202	D	N	Y
Bull Run	380260	E	Y	Y
Silver Lake	380980	E	N	Y
Andrews Exp. Forest	381020	D	Y	Y
Vines Hill	381120	A	Y	Y
Starkey Exp. Forest	381800	B	Y	Y
Santee NWR	420680	E	Y	Y
Walker Branch	440040	A	Y	Y
Giles County	441140	A	Y	Y
Elkmont	441190	B	Y	Y
Beeville	450350	A	Y	Y
Attwater Prairie Chicken	451060	E	Y	Y
Longview	452180	A	Y	Y
Forest Seed Center	453800	B	Y	Y
Victoria	455350	A	Y	Y
Horton's Station	481300	A	Y	Y
Big Meadows	482890	B	Y	Y
Sullivan Lake	491540	E	Y	Y
Popple River	510960	B	Y	Y
Suring	512500	B	Y	Y
Trout Lake	513640	B	Y	Y
Lake Geneva	513680	B	Y	Y
Spooner	513700	D	Y	Y
Snowy Range-Glacier Lake	520020	E	Y	Y
Snowy Range - Nash Fork	520021	E	Y	Y

* (A) AC only; (B) AC w/ Aerochem trickle charger/battery; (C) Battery only; (D) Battery w/ external AC powered charger; (E) Solar; (F) Other.

TABLE 5, PAGE 2. AEROCHEM METRICS COLLECTOR SYSTEM CHECKS

Site Name	ID	Sensor Clean	Bucket Tie-down Used	Correct Counter-Weight	Clutch Worn
Sand Mountain	011020	Y	Y	Y	N
Niwot Saddle	060220	Y	Y	Y	Y
Sugarloaf	060221	Y	Y	Y	Y
Buffalo Pass-Summit Lake	061920	Y	Y	Y	Y
Buffalo Pass - Dry Lake	061921	Y	Y	Y	N
Engineer Mountain	061980	Y	Y	Y	Y
Molas Pass	061981	Y	Y	Y	N
Bradford Forest	100360	Y	N	Y	N
Kennedy Space Center	100380	Y	Y	Y	N
Everglades National Park	101190	Y	Y	Y	N
Quincy	101400	Y	Y	Y	N
Verna Well Field	104100	Y	Y	Y	N
Bellville	112040	Y	Y	Y	N
Georgia Station	114140	Y	Y	Y	N
Tifton ARS	115000	Y	Y	Y	N
Headquarters	130480	Y	Y	Y	Y
Reynolds Creek	131180	Y	Y	Y	Y
Shabbona	141800	Y	Y	Y	N
Argonne	141980	^	^	^	^
Huntington Reservoir	152020	Y	Y	Y	N
Indiana Dunes	153420	Y	Y	Y	N
Purdue	154100	Y	Y	Y	N
Lilley Cornett Woods	182260	Y	N	Y	Y
Acadia National Park	200011	Y	N	Y	N
Caribou	200045	Y	Y	Y	N
Presque Isle	200046	Y	Y	Y	N
Bridgeton	200277	Y	Y	Y	N
Greenville	200935	Y	Y	Y	N
Marcell Exp. Forest	241660	Y	Y	Y	Y
Fernberg	241840	Y	Y	Y	Y
Camp Ripley	242360	Y	Y	Y	N
Clinton	251080	Y	N	Y	N
Meridian	251460	Y	Y	Y	N
Coffeeville	253000	Y	Y	Y	N
Lewiston	340320	Y	N	Y	N

TABLE 5, PAGE 2 (cont). AEROCHEM METRICS COLLECTOR SYSTEM CHECKS

Site Name	ID	Sensor Clean	Bucket Tie-down Used	Correct Counter-Weight	Clutch Worn
Coweeta	342500	Y	N	Y	N
Alsea Guard Station	380200	Y	Y	Y	N
Hyslop Farm	380202	Y	Y	N	N
Bull Run	380260	Y	Y	Y	N
Silver Lake	380980	Y	Y	Y	N
Andrews Exp. Forest	381020	Y	Y	Y	N
Vines Hill	381120	Y	Y	Y	Y
Starkey Exp. Forest	381800	Y	Y	Y	N
Santee NWR	420680	Y	Y	Y	^
Walker Branch	440040	Y	N	Y	N
Giles County	441140	Y	Y	Y	N
Elkmont	441190	Y	N	Y	N
Beeville	450350	Y	Y	Y	N
Attwater Prairie Chicken	451060	Y	Y	Y	N
Longview	452180	Y	Y	Y	Y
Forest Seed Center	453800	Y	Y	Y	N
Victoria	455350	Y	Y	Y	N
Horton's Station	481300	Y	N	Y	N
Big Meadows	482890	Y	Y	N	N
Sullivan Lake	491540	Y	N	Y	Y
Popple River	510960	Y	Y	Y	N
Suring	512500	Y	Y	Y	N
Trout Lake	513640	Y	Y	Y	Y
Lake Geneva	513680	Y	Y	Y	N
Spooner	513700	Y	Y	Y	N
Snowy Range-Glacier Lake	520020	Y	Y	Y	Y
Snowy Range - Nash Fork	520021	Y	Y	Y	N

Collector Level. The precipitation collector should be level so that the collection efficiency will not be biased by wind direction or variations in effective bucket opening areas. Only five of sixty collectors examined (8%) were not level. In most cases the collectors were off level by small amounts. It is not believed the effect of this variance would be measurable.

Collector Stable. The precipitation collector should be mounted firmly so that it will not move in strong winds. Each of the sixty-one collectors examined was judged to be stably mounted (i.e., it could not be rocked easily by hand).

Sensor Clean. The collector's sensor should be clean. Each of the sixty-one collector sensors examined was clean. The usual effect of a dirty sensor is to prolong the length of time the wet bucket stays uncovered after an event, increasing the likelihood of contamination.

Counterweight. The moving bucket lid should be properly counter weighted so the lid can be moved without excessive motor strain or clutch slippage. Improper counterweighting is usually found at sites which have added snow roofs. Only two of sixty-one site collectors were found to have improper counterweights. For these two, there was no sign of excessive clutch wear.

Clutch Wear. The motor box clutch assembly should not show signs of excessive slippage or wear as evidenced by a shiny clutch surface or rounded-off indent. Fourteen of sixty sites (23%) had evidence of clutch wear or slippage. However, other tests, such as the assembly's ability to lift two or more Belfort gauge weights without slipping, showed that eight of these 14 were operating properly. There are several causes of clutch slippage in addition to improper counterweighting discussed above. The usual result of serious clutch slippage is that samples are not collected because the bucket lid fails to move off the wet bucket at the start of a precipitation event.

Bucket Tie Down. Both the wet and dry collection buckets should be secured to the collector with tie down straps to prevent their being blown out during strong winds. Nine of the sixty-one sites (15%) did not secure the buckets. However, the actual incidence of sample loss due to this variance is probably rare.

Precipitation Collector Performance Checks

Table 6 lists the results of performance checks conducted on the Aerochem Metrics precipitation collectors.

TABLE 6, PAGE 1. AEROCHEM METRICS COLLECTOR PERFORMANCE CHECKS

Site Name	ID	No Gaps; Bucket-lid Seal	Lid Tension (g)	Lid Drop (mm)	Voltage to Event Marker
Sand Mountain	011020	Y	2300	18	13.64
Niwot Saddle	060220	Y	2000	10	10.50
Sugarloaf	060221	Y	2000	5	11.96
Buffalo Pass-Summit Lake	061920	Y	2500	16	12.40
Buffalo Pass - Dry Lake	061921	Y	2000	15	14.78
Engineer Mountain	061980	Y	2500	^	12.78
Molas Pass	061981	Y	2500	10	11.98
Bradford Forest	100360	Y	1700	7	11.92
Kennedy Space Center	100380	Y	2000	18	12.06
Everglades National Park	101190	Y	2000	12	13.20
Quincy	101400	^	^	^	10.50
Verna Well Field	104100	Y	2500	18	10.60
Bellville	112040	^	^	^	^
Georgia Station	114140	Y	3000	15	12.50
Tifton ARS	115000	Y	2600	17	12.80
Headquarters	130480	Y	2500	18	12.89
Reynolds Creek	131180	Y	2500	18	12.50
Shabbona	141800	Y	1500	14	12.70
Argonne	141980	^	^	^	^
Huntington Reservoir	152020	Y	2500	15	12.96
Indiana Dunes	153420	Y	2000	14	12.50
Purdue	154100	Y	2500	11	12.14
Lilley Cornett Woods	182260	Y	2500	10	11.35
Acadia National Park	200011	Y	2600	16	13.10
Caribou	200045	Y	2500	8	11.60
Presque Isle	200046	Y	2500	18	12.55
Bridgeton	200277	Y	2400	12	12.56
Greenville	200935	Y	2800	19	16.33
Marcell Exp. Forest	241660	Y	2500	19	12.31
Fernberg	241840	Y	3500	16	12.40
Camp Ripley	242360	Y	2500	17	12.89
Clinton	251080	Y	2400	15	13.33
Meridian	251460	Y	2100	14	11.80
Coffeeville	253000	Y	2200	13	13.45
Lewiston	340320	Y	2000	21	12.78

TABLE 6, PAGE 1 (cont). AEROCHEM METRICS COLLECTOR PERFORMANCE CHECKS

Site Name	ID	No Gaps; Bucket-lid Seal	Lid Tension (g)	Lid Drop (mm)	Voltage to Event Marker
Coweeta	342500	Y	2500	17	12.14
Alsea Guard Station	380200	Y	2200	14	12.51
Hyslop Farm	380202	Y	2600	14	11.78
Bull Run	380260	Y	2500	10	13.28
Silver Lake	380980	Y	2200	14	12.78
Andrews Exp. Forest	381020	Y	2500	7	12.48
Vines Hill	381120	Y	2000	8	13.12
Starkey Exp. Forest	381800	Y	2500	19	12.40
Santee NWR	420680	Y	^	^	12.20
Walker Branch	440040	Y	2000	13	12.85
Giles County	441140	Y	2800	^	13.20
Elkmont	441190	Y	1500	15	13.50
Beeville	450350	Y	3500	9	^
Attwater Prairie Chicken	451060	Y	2000	19	12.34
Longview	452180	Y	2000	17	13.30
Forest Seed Center	453800	Y	3000	19	12.15
Victoria	455350	Y	2500	18	11.91
Horton's Station	481300	Y	3000	16	12.80
Big Meadows	482890	^	^	^	^
Sullivan Lake	491540	Y	2000	14	13.86
Popple River	510960	Y	2500	14	13.01
Suring	512500	Y	3000	17	13.61
Trout Lake	513640	Y	3000	16	11.20
Lake Geneva	513680	Y	2000	10	12.77
Spooner	513700	Y	1500	12	14.30
Snowy Range-Glacier Lake	520020	Y	3000	12	17.30
Snowy Range - Nash Fork	520021	Y	2000	10	14.08

TABLE 6, PAGE 2. AEROCHEM METRICS COLLECTOR PERFORMANCE CHECKS

Site Name	ID	Sensor Temp, C Ambient	Sensor Temp, C Activated	Resistance to Trigger Sensor, Kohm
Sand Mountain	011020	9	48	79
Niwot Saddle	060220	13	41	65
Sugarloaf	060221	38	76	85
Buffalo Pass-Summit Lake	061920	25	55	75
Buffalo Pass - Dry Lake	061921	35	59	84
Engineer Mountain	061980	39	61	87
Molas Pass	061981	15	50	86
Bradford Forest	100360	24	65	64
Kennedy Space Center	100380	29	61	77
Everglades National Park	101190	29	70	79
Quincy	101400	^	^	^
Verna Well Field	104100	32	70	59
Bellville	112040	^	^	^
Georgia Station	114140	8	36	79
Tifton ARS	115000	16	53	94
Headquarters	130480	39	67	79
Reynolds Creek	131180	29	60	75
Shabbona	141800	11	40	67
Argonne	141980	^	^	^
Huntington Reservoir	152020	14	58	104
Indiana Dunes	153420	14	59	80
Purdue	154100	25	51	108
Lilley Cornett Woods	182260	20	60	85
Acadia National Park	200011	35	71	83
Caribou	200045	34	59	97
Presque Isle	200046	17	52	69
Bridgeton	200277	38	70	78
Greenville	200935	24	75	89
Marcell Exp. Forest	241660	40	63	84
Fernberg	241840	36	52	83
Camp Ripley	242360	30	72	72
Clinton	251080	25	58	78
Meridian	251460	11	33	88
Coffeeville	253000	18	65	81
Lewiston	340320	23	58	75

TABLE 6, PAGE 2 (cont). AEROCHEM METRICS COLLECTOR PERFORMANCE CHECKS

Site Name	ID	Sensor Temp, C Ambient	Sensor Temp, C Activated	Resistance to Trigger Sensor, Kohm
Coweeta	342500	18	56	98
Alsea Guard Station	380200	18	54	82
Hyslop Farm	380202	23	50	72
Bull Run	380260	30	47	81
Silver Lake	380980	29	59	80
Andrews Exp. Forest	381020	31	72	87
Vines Hill	381120	30	60	82
Starkey Exp. Forest	381800	24	69	76
Santee NWR	420680	^	^	^
Walker Branch	440040	14	58	88
Giles County	441140	^	70	^
Elkmont	441190	11	59	89
Beeville	450350	16	15	85
Attwater Prairie Chicken	451060	10	36	60
Longview	452180	18	50	78
Forest Seed Center	453800	14	49	82
Victoria	455350	15	41	80
Horton's Station	481300	32	60	77
Big Meadows	482890	^	^	^
Sullivan Lake	491540	27	70	87
Popple River	510960	^	^	110
Suring	512500	^	^	90
Trout Lake	513640	^	^	76
Lake Geneva	513680	40	70	77
Spooner	513700	33	32	104
Snowy Range-Glacier Lake	520020	29	90	81
Snowy Range - Nash Fork	520021	35	75	97

Cover Seats Properly on Wet Bucket. The collector's bucket cover should fit tightly and evenly on the rim of the wet (and dry) bucket so that dust cannot enter during dry periods (and so that the lid liner is protected during wet periods). None of 58 collectors that could be examined in 1987 had bucket-lid seal problems.

Lid Tension. The force that the bucket cover exerts against the rim of the collection bucket may be assessed by lifting the lid slightly above the bucket and reading the force (in grams) required to do so. A spring scale is used. Generally, tensions of 1500 g or greater are found. Three sites had lid tension of 1500 g. The average lid tension was 2384 $\pm$ 434 g.

Lid Drop Distance. Another measure of adequate lid/bucket seal tension is the lid drop distance--the distance the lid drops when the wet bucket is momentarily removed. The Central Analytical Laboratory of the NADP/NTN network has found that a distance of 3 mm or greater is required to give good, dust-free seals.

Not all collectors were checked in this manner because the test was not instituted until later in the program. Of fifty-six site collectors checked, none had a lid drop distance of 3 mm or less. Minimum, maximum, and mean distances were 5, 21, and 14.2 $\pm$ 3.7 mm.

Voltage to Event Marker. In the wet-side open mode, the Aerochem Metrics unit should send a signal of 14 $\pm$ 3 volts to the event marker solenoid of the Belfort rain gauge. Zero voltage or values outside the prescribed range are indications of problems with the Aerochem Metrics motor box or the battery, if one is used to power the unit. Of fifty-eight units checked, three were lower and one higher than the acceptable range. The mean voltage was 12.74 $\pm$ 1.15. The highest voltage was 17.3 at the Snowy Range-Glacier Lake site. It may be that the solar panel there is overcharging the battery. The low voltages were found at the Niwot Saddle, Quincy, and Verna Well Field sites.

Unactivated Sensor Temperature. Generally, the temperature of the precipitation collector sensor is at ambient level when there is no precipitation. If the ambient temperature is below 4°C, the sensor heater should come on, at a lower power level, to melt ice or snow that may fall. A sensor should not be heating at ambient temperatures above 4°C unless it is raining. If it is heating prior to the rain, light rainfall striking the sensor may evaporate before the circuit can be made to open the lid. None of the fifty-three sensors checked showed irregular heating at ambient temperatures.

Activated Sensor Temperature. When activated by precipitation, the Aerochem Metrics sensor causes the cover to move off the wet-side collection bucket. To speed precipitation evaporation and thus reduce the time the wet-side bucket is open after precipitation ceases, a heater circuit beneath the base plate of the sensor is energized and the temperature of the sensor (as measured at the base plate) rises. The circuit is thermistor-limited and is adjusted to 50-60°C (122-140°F) at the factory.

A total of fifty-eight sensors were checked during the 1987 visits. Sensors at four sites were not checked since heavy rains were occurring at the time of the visit. Of the fifty-eight, two were not heating (3%), one (Snowy Range-Glacier Lake) was overheating (90°C), and 55 were judged to be heating properly. Temperatures at 51 of the 55 sites were checked using a thermocouple and digital meter. Of these fifty-one, the lowest temperature was 33°C (Meridian), the highest was 76°C (Sugarloaf), and the average temperature was 58.2 $\pm$ 10.8°C. Of those fifty-one, ten (20%) heated below 50°C, twenty-two (45%) heated to the manufactured range of 50-60°C, and nineteen (37%) were above 60°C.

Resistance to Trigger Sensor. The sensor of the Aerochem Metrics collector activates circuitry to open the cover when water droplets bridge the gap between the grid and the base plate elements of the sensor assembly. According to factory specifications, this occurs when the resistance between the elements is reduced to 80 Kohms. This resistance is sufficiently sensitive to cause activation by relatively pure water (i.e., water of very low conductivity, such as deionized water).

All of the fifty-six sensors checked caused the circuit to activate when distilled water was applied to the grid and base plate. The low, high, and average resistances measured by bridging the grid and the base plate through a variable resistance box were 59.1, 110.0, and 82.3 $\pm$ 10.3 Kohms.

Rain Gauge System Checks

Results of five system checks of the installation and operation of the Belfort gauge are given in Table 7. Also included is a column indicating that 20 of the 59 gauges checked (34%) were calibrated during the site visit.

Gauge Level. The rain gauge should be level so that precipitation collection efficiency is not biased by wind direction or by variation in effective exposure area. Five of the sixty-one rain gauges inspected (8%) were out of level by small amounts.

TABLE 7, PAGE 1. BELFORT RAIN GAUGE SYSTEM CHECKS

Site Name	ID	Gauge Level	Orifice Round	Alter Shield
Sand Mountain	011020	Y	Y	N
Niwot Saddle	060220	Y	Y	N
Sugarloaf	060221	Y	Y	Y
Buffalo Pass-Summit Lake	061920	Y	Y	N
Buffalo Pass - Dry Lake	061921	Y	Y	Y
Engineer Mountain	061980	Y	Y	Y
Molas Pass	061981	Y	Y	Y
Bradford Forest	100360	Y	Y	N
Kennedy Space Center	100380	Y	Y	N
Everglades National Park	101190	Y	Y	N
Quincy	101400	Y	Y	N
Verna Well Field	104100	Y	Y	N
Bellville	112040	Y	Y	N
Georgia Station	114140	Y	Y	N
Tifton ARS	115000	Y	Y	N
Headquarters	130480	Y	Y	N
Reynolds Creek	131180	Y	Y	Y
Shabbona	141800	Y	Y	N
Argonne	141980	Y	Y	N
Huntington Reservoir	152020	Y	Y	Y
Indiana Dunes	153420	Y	Y	N
Purdue	154100	Y	Y	N
Lilley Cornett Woods	182260	Y	Y	N
Acadia National Park	200011	Y	Y	N
Caribou	200045	Y	Y	Y
Presque Isle	200046	Y	Y	N
Bridgeton	200277	N	Y	N
Greenville	200935	Y	Y	N
Marcell Exp. Forest	241660	Y	Y	N
Fernberg	241840	Y	Y	N
Camp Ripley	242360	N	Y	N
Clinton	251080	Y	Y	N
Meridian	251460	Y	Y	N
Coffeeville	253000	N	Y	N
Lewiston	340320	Y	Y	N

TABLE 7, PAGE 1 (cont). BELFORT RAIN GAUGE SYSTEM CHECKS

Site Name	ID	Gauge Level	Orifice Round	Alter Shield
Coweeta	342500	Y	Y	N
Alsea Guard Station	380200	N	Y	N
Hyslop Farm	380202	Y	Y	N
Bull Run	380260	Y	Y	Y
Silver Lake	380980	Y	Y	Y
Andrews Exp. Forest	381020	Y	Y	Y
Vines Hill	381120	Y	Y	N
Starkey Exp. Forest	381800	N	Y	Y
Santee NWR	420680	Y	Y	N
Walker Branch	440040	Y	Y	N
Giles County	441140	Y	Y	N
Elkmont	441190	Y	Y	N
Beeville	450350	Y	Y	N
Attwater Prairie Chicken	451060	Y	Y	N
Longview	452180	Y	Y	N
Forest Seed Center	453800	Y	Y	Y
Victoria	455350	Y	Y	N
Horton's Station	481300	Y	Y	N
Big Meadows	482890	^	^	N
Sullivan Lake	491540	Y	Y	N
Popple River	510960	Y	Y	N
Suring	512500	Y	Y	N
Trout Lake	513640	Y	Y	N
Lake Geneva	513680	Y	Y	N
Spooner	513700	Y	Y	N
Snowy Range-Glacier Lake	520020	Y	Y	Y
Snowy Range - Nash Fork	520021	Y	Y	Y

TABLE 7, PAGE 2. BELFORT RAIN GAUGE SYSTEM CHECKS

Site Name	ID	Time Correct +/- 1 hr	Dampening Fluid OK	Gauge Calibrated by RTI
Sand Mountain	011020	Y	Y	N
Niwot Saddle	060220	Y	Y	Y
Sugarloaf	060221	Y	Y	N
Buffalo Pass-Summit Lake	061920	^	Y	N
Buffalo Pass - Dry Lake	061921	Y	Y	N
Engineer Mountain	061980	Y	Y	N
Molas Pass	061981	Y	Y	Y
Bradford Forest	100360	Y	Y	^
Kennedy Space Center	100380	Y	Y	N
Everglades National Park	101190	Y	Y	Y
Quincy	101400	Y	Y	^
Verna Well Field	104100	Y	Y	N
Bellville	112040	Y	Y	Y
Georgia Station	114140	Y	Y	N
Tifton ARS	115000	Y	Y	N
Headquarters	130480	Y	Y	Y
Reynolds Creek	131180	Y	Y	N
Shabbona	141800	Y	N	Y
Argonne	141980	Y	Y	N
Huntington Reservoir	152020	Y	Y	Y
Indiana Dunes	153420	Y	Y	N
Purdue	154100	Y	Y	Y
Lilley Cornett Woods	182260	Y	N	N
Acadia National Park	200011	Y	N	N
Caribou	200045	Y	N	N
Presque Isle	200046	Y	N	N
Bridgeton	200277	Y	Y	N
Greenville	200935	Y	Y	N
Marcell Exp. Forest	241660	Y	Y	N
Fernberg	241840	N	Y	Y
Camp Ripley	242360	Y	Y	Y
Clinton	251080	Y	Y	N
Meridian	251460	Y	Y	N
Coffeeville	253000	Y	Y	Y
Lewiston	340320	Y	N	Y

TABLE 7, PAGE 2 (cont). BELFORT RAIN GAUGE SYSTEM CHECKS

Site Name	ID	Time Correct +/- 1 hr	Dampening Fluid OK	Gauge Calibrated by RTI
Coweeta	342500	Y	Y	Y
Alsea Guard Station	380200	Y	N	N
Hyslop Farm	380202	Y	N	N
Bull Run	380260	Y	N	N
Silver Lake	380980	Y	Y	N
Andrews Exp. Forest	381020	Y	Y	N
Vines Hill	381120	Y	Y	N
Starkey Exp. Forest	381800	Y	Y	Y
Santee NWR	420680	Y	Y	Y
Walker Branch	440040	Y	Y	^
Giles County	441140	Y	^	N
Elkmont	441190	Y	Y	N
Beeville	450350	Y	Y	Y
Attwater Prairie Chicken	451060	Y	Y	Y
Longview	452180	Y	Y	N
Forest Seed Center	453800	Y	Y	N
Victoria	455350	Y	Y	N
Horton's Station	481300	Y	N	Y
Big Meadows	482890	Y	^	N
Sullivan Lake	491540	Y	Y	Y
Popple River	510960	Y	Y	N
Suring	512500	Y	Y	N
Trout Lake	513640	Y	Y	N
Lake Geneva	513680	Y	Y	N
Spooner	513700	Y	Y	Y
Snowy Range-Glacier Lake	520020	Y	Y	N
Snowy Range - Nash Fork	520021	Y	Y	N

Opening Round. The Belfort rain gauge calibration relationship requires that the collection orifice be a circular orifice, eight inches in diameter. An out-of-round orifice may alter the cross-sectional area of the orifice and hence the gauge calibration. None of the sixty-one gauges examined were out-of-round by more than 1/8 inch (based on two measurements of the diameters made at right angles to each other).

Alter Shields. Alter shields may be used with rain gauges in the NADP/NTN network to abate strong winds near the gauge and improve collection efficiency. Fourteen of sixty-two sites (23%) were so equipped.

Chart Recorders. When checked at the time of the visit, the chart recorders should indicate the correct time ± one hour. The rain gauge chart recorder was off by more than one hour at only 1 of the 61 sites checked.

Dampening Fluid Levels. The Belfort gauge dampening fluid reservoir should be filled to within 0.25 inch of the top to reduce pen "noise" created by strong winds. Charts showing excessive pen noise are difficult to read accurately. The dampening fluid level was low at 10 (17%) of the 60 sites checked.

Rain Gauge Performance Check

The rain gauge calibration was checked using Belfort gauge calibration weights. Results of the checks for 1987 are shown in Table 8. Fifty-five of the 59 gauges (93%) were in calibration (within ± 0.1 inch) up to five inches depth. At a depth of six inches, only 76 percent were in calibration. Errors associated with the crossover point increased rapidly at the six inch depth point. Because most rain amounts are measured in the 0-5 inch range (except when winterized), and because the event depth is measured as the difference in chart reading before and after the event, few measurable errors in precipitation mass measurements are expected due to inaccurate rain gauge calibration. Twenty of the 51 rain gauges checked (34%) were calibrated during the site visits.

Sample Collection Procedures

Sample collection procedures were discussed with site operators to ascertain whether specified procedures were adhered to. Key among these are five procedures listed below and shown with results in Table 9.

1. Is the collection bucket held only on the outside? Special care should be taken to avoid contaminating the precipitation sample.

TABLE 8. BELFORT RAIN GAUGE PERFORMANCE CHECKS

Site Name	Depth At Which Check Exceeds +/- 0.1 Inch Agreement											
	1	2	3	4	5	6	7	8	9	10	11	12
Sand Mountain	-	-	-	-	-	-	-	-	-	-	-	-
Niwot Saddle	-	-	-	-	X	^	X	X	X	X	X	X
Moasl Pass	-	-	-	-	-	X	X	X	X	X	X	X
Bradford Forest	-	-	-	-	-	-	-	-	-	-	-	-
Kennedy Space Center	-	-	-	-	-	-	-	-	-	-	-	-
Everglades National Park	-	-	-	-	-	X	X	X	X	X	X	-
Quincy	^	^	^	^	^	^	^	^	^	^	^	^
Verna Well Field	-	-	-	-	-	-	-	-	-	-	-	-
Bellville	-	-	-	-	-	-	X	X	X	X	X	X
Georgia Station	-	-	-	-	-	-	-	-	-	-	-	-
Tifton ARS	-	-	-	-	-	-	-	-	-	-	-	-
Headquarters	-	-	-	-	-	-	X	-	-	X	X	X
Reynolds Creek	-	-	-	-	-	-	^	^	^	^	^	^
Shabbona	-	-	-	-	-	X	X	X	X	X	X	X
Argonne	-	-	-	-	-	-	-	-	-	-	-	-
Huntington Reservoir	-	-	-	-	-	X	X	X	X	X	X	X
Purdue	-	-	-	-	-	X	-	-	-	-	-	-
Lilley Cornett Woods	-	-	-	-	-	-	-	-	-	-	-	-
Acadia National Park	-	-	-	-	-	-	-	-	-	-	-	-
Caribou	-	-	-	-	-	X	X	X	X	X	X	X
Presque Isle	-	-	-	-	-	-	X	X	X	X	X	X
Bridgeton	-	-	-	-	-	-	-	-	-	-	-	X
Greenville	-	-	-	-	-	-	-	-	-	-	-	-
Camp Ripley	-	-	-	-	-	X	X	X	X	X	X	X
Clinton	-	-	-	-	-	-	-	-	-	-	-	-
Meridian	-	-	-	-	-	-	X	X	X	X	X	X
Coffeeville	-	-	-	-	-	X	X	X	X	X	X	X
Lewiston	-	X	X	X	X	X	X	X	X	X	X	X
Coweeta	-	-	-	-	-	X	X	X	X	X	X	X
Alsea Guard Station	-	-	-	-	-	-	-	-	-	-	-	-
Hyslop Farm	-	-	-	-	-	-	-	-	-	-	-	X
Bull Run	-	-	-	-	-	-	-	-	-	-	-	-
Silver Lake	-	-	-	-	-	-	-	-	-	-	-	-
Andrews Exp. Forest	-	-	-	-	-	-	-	-	-	-	-	-
Vines Hill	-	-	-	-	-	-	-	-	-	-	-	-

Key: - = OK x = outside +/- 0.1 inch ^ = not checked

TABLE 8 (cont). BELFORT RAIN GAUGE PERFORMANCE CHECKS

Site Name	Depth At Which Check Exceeds +/- 0.1 Inch Agreement											
	1	2	3	4	5	6	7	8	9	10	11	12
Starkey Exp. Forest	-	-	-	-	-	X	X	X	X	X	X	X
Santee NWR	-	-	-	X	^	X	X	X	X	X	X	X
Walker Branch	^	^	^	^	^	^	^	^	^	^	^	^
Elkmont	-	-	-	-	-	-	-	-	-	-	-	-
Beeville	-	-	-	-	-	-	-	X	X	X	X	X
Attwater Prairie Chicken	-	-	-	-	-	X	X	X	X	X	X	X
Longview	-	-	-	-	-	-	-	-	-	-	-	-
Forest Seed Center	-	-	-	-	-	-	-	-	-	-	-	-
Victoria	-	-	-	-	-	-	-	-	-	-	-	-
Horton's Station	-	-	-	-	-	X	X	-	X	X	X	X
Big Meadows	^	^	^	^	^	^	^	^	^	^	^	^
Sullivan Lake	-	-	-	-	-	-	X	X	X	X	X	-
Popple River	-	-	-	-	-	-	-	-	-	-	-	-
Suring	-	-	-	-	-	-	-	-	-	-	-	-
Trout Lake	-	-	-	-	-	-	-	-	-	-	-	-
Lake Geneva	-	-	-	-	-	-	-	-	-	-	-	-
Snowy Range-Nash Fork	-	-	-	-	X	X	X	X	X	X	X	X

Key: - = OK x = outside +/- 0.1 inch ^ = not checked

TABLE 9. SAMPLE COLLECTION PROCEDURES

Site Name	ID	Bucket Held Only On Outside	Bucket Change, 7 Days	Weekly Equipment Check	Contam. Check At Site	Bucket Bagged/Boxed to Lab
Sand Mountain	011020	Y	Y	Y	Y	Y
Niwot Saddle	060220	Y	Y	Y	Y	Y
Surgarloaf	060221	Y	Y	Y	Y	Y
Buffalo Pass-Summit Lake	061920	Y	Y	Y	Y	Y
Buffalo Pass - Dry Lake	061921	Y	Y	Y	Y	Y
Engineer Mountain	061980	Y	Y	Y	Y	Y
Molas Pass	061981	Y	Y	Y	Y	Y
Bradford Forest	100360	Y	Y	Y	Y	Y
Kennedy Space Center	100380	Y	Y	Y	Y	Y
Everglades National Park	101190	Y	Y	Y	Y	Y
Quincy	101400	Y	Y	Y	Y	Y
Verna Well Field	104100	Y	Y	Y	Y	N
Bellville	112040	Y	Y	Y	Y	Y
Georgia Station	114140	Y	Y	Y	Y	Y
Tifton ARS	115000	Y	Y	Y	Y	Y
Headquarters	130480	Y	Y	Y	Y	Y
Reynolds Creek	131180	Y	Y	Y	Y	Y
Shabbona	141800	Y	Y	Y	Y	Y
Argonne	141980	Y	Y	Y	Y	Y
Huntington Reservoir	152020	Y	Y	Y	Y	Y
Indiana Dunes	153420	Y	Y	Y	Y	Y
Purdue	154100	Y	Y	Y	Y	Y
Lilley Cornett Woods	182260	Y	Y	Y	Y	Y
Acadia National Park	200011	Y	Y	Y	Y	Y
Caribou	200045	Y	Y	Y	Y	N
Presque Isle	200046	Y	Y	Y	Y	Y
Bridgeton	200277	Y	Y	Y	Y	Y
Greenville	200935	Y	Y	Y	Y	Y
Marcell Exp. Forest	241660	Y	Y	Y	Y	Y
Fernberg	241840	Y	Y	Y	Y	Y
Camp Ripley	242360	Y	Y	Y	Y	Y
Clinton	251080	Y	Y	Y	Y	N
Meridian	251460	Y	Y	Y	Y	N
Coffeeville	253000	Y	Y	Y	Y	Y
Lewiston	340320	Y	Y	N	Y	N

TABLE 9 (cont). SAMPLE COLLECTION PROCEDURES

Site Name	ID	Bucket Held Only On Outside	Bucket Change, 7 Days	Weekly Equipment Check	Contam. Check At Site	Bucket Bagged/Boxed to Lab
Coweeta	342500	Y	Y	Y	Y	Y
Alsea Guard Station	380200	Y	Y	Y	Y	Y
Hyslop Farm	380202	Y	Y	Y	Y	Y
Bull Run	380260	Y	Y	Y	Y	Y
Silver Lake	380980	Y	Y	Y	Y	Y
Andrews Exp. Forest	381020	Y	Y	Y	Y	N
Vines Hill	381120	Y	Y	Y	Y	Y
Starkey Exp. Forest	381800	Y	Y	Y	Y	Y
Santee NWR	420680	Y	Y	Y	Y	Y
Walker Branch	440040	Y	Y	Y	Y	N
Giles County	441140	Y	Y	Y	Y	Y
Elkmont	441190	Y	Y	Y	Y	Y
Beeville	450350	Y	Y	Y	Y	Y
Attwater Prairie Chicken	451060	Y	Y	Y	Y	Y
Longview	452180	Y	Y	Y	Y	Y
Forest Seed Center	453800	Y	Y	Y	Y	Y
Victoria	455350	Y	Y	Y	Y	N
Horton's Station	481300	Y	Y	Y	Y	Y
Big Meadows	482890	Y	Y	Y	Y	Y
Sullivan Lake	491540	Y	Y	Y	Y	Y
Popple River	510960	Y	Y	Y	Y	Y
Suring	512500	Y	Y	Y	Y	Y
Trout Lake	513640	Y	Y	Y	Y	Y
Lake Geneva	513680	Y	Y	Y	Y	Y
Spooner	513700	Y	Y	Y	Y	Y
Snowy Range-Glacier Lake	520020	Y	Y	Y	Y	Y
Snowy Range - Nash Fork	520021	Y	Y	Y	Y	Y

2. Is the sample bucket changed every seven days, on Tuesday? The sample bucket should be changed every Tuesday morning unless it is raining, etc. If it is raining, the sample bucket should be changed as soon as the event ends or the following morning at 9 a.m., whichever comes first.

3. Are the rain gauge and collector checked for proper operation during the weekly site visit?

4. Is the sample visually checked for contamination (bird droppings, leaves, etc.) prior to transport to the field laboratory? Some contaminants might be seen at the site before they dissolve en route to the field laboratory.

5. Is the sample bucket enclosed in its plastic bag and shipping container prior to shipment to the field laboratory? This procedure is essential to prevent sample contamination or spillage.

Most operators were using proper collection procedures and no instances of contamination were noted. Operators were also checking for sample contamination while at the site.

Only one site operator was not able to make a weekly equipment check. Seven operators did not bag and box the bucket before transporting it to the field laboratory. In those cases, the sites were within walking distance of the field laboratory.

FIELD LABORATORY SURVEY

Systems Check of Field Laboratory

Table 10 lists information on seven systems audit checks that were made at each field laboratory. Field laboratories had adequate space and were clean. Fourteen sites (23%) did not have air conditioning but were usually in areas that would need it only rarely. Required records were kept and report forms were filled out correctly in all cases. Rain gauge charts were annotated fully with site name, date, time on, time off, etc. Field samples were shipped to CAL, generally within three days. Proper techniques for weighing samples were followed in all instances.

pH and Conductivity Measurement Techniques

In order to make accurate and precise pH and conductivity measurements, the analyst must be familiar with the measurement equipment, follow appropriate calibration procedures, and use measurement techniques consistent with good

TABLE 10, PAGE 1. SYSTEM CHECKS OF FIELD LABORATORY

Site Name	ID	Space Adequate	Laboratory Clean	Temperature Control	Proper Weighing Technique
Sand Mountain	011020	Y	Y	Y	Y
Niwot Saddle	060220	Y	Y	Y	Y
Sugarloaf	060221	Y	Y	Y	Y
Buffalo Pass-Summit Lake	061920	Y	Y	Y	Y
Buffalo Pass - Dry Lake	061921	Y	Y	N	Y
Engineer Mountain	061980	Y	Y	Y	Y
Molas Pass	061981	Y	Y	Y	Y
Bradford Forest	100360	Y	N	Y	Y
Kennedy Space Center	100380	Y	Y	Y	Y
Everglades National Park	101190	Y	Y	Y	Y
Quincy	101400	Y	Y	Y	Y
Verna Well Field	104100	Y	Y	Y	Y
Bellville	112040	Y	Y	Y	Y
Georgia Station	114140	Y	Y	Y	Y
Tifton ARS	115000	Y	Y	N	Y
Headquarters	130480	Y	Y	Y	Y
Reynolds Creek	131180	Y	Y	N	Y
Shabbona	141800	Y	Y	N	Y
Argonne	141980	Y	Y	Y	Y
Huntington Reservoir	152020	Y	Y	Y	Y
Indiana Dunes	153420	Y	Y	Y	Y
Purdue	154100	Y	Y	Y	Y
Lilley Cornett Woods	182260	Y	Y	Y	Y
Acadia National Park	200011	Y	Y	Y	Y
Caribou	200045	Y	Y	Y	Y
Presque Isle	200046	Y	Y	Y	Y
Bridgeton	200277	Y	Y	Y	Y
Greenville	200935	Y	Y	Y	Y
Marcell Exp. Forest	241660	Y	Y	Y	Y
Fernberg	241840	Y	Y	Y	Y
Camp Ripley	242360	Y	Y	N	Y
Clinton	251080	Y	Y	Y	Y
Meridian	251460	Y	Y	Y	Y
Coffeeville	253000	Y	Y	N	Y
Lewiston	340320	Y	Y	Y	Y

TABLE 10, PAGE 1 (cont). SYSTEM CHECKS OF FIELD LABORATORY

Site Name	ID	Space Adequate	Laboratory Clean	Temperature Control	Proper Weighing Technique
Coweeta	342500	Y	Y	Y	Y
Alsea Guard Station	380200	Y	Y	Y	Y
Hyslop Farm	380202	Y	Y	Y	Y
Bull Run	380260	Y	Y	Y	Y
Silver Lake	380980	Y	Y	Y	Y
Andrews Exp. Forest	381020	Y	Y	Y	Y
Vines Hill	381120	Y	Y	N	Y
Starkey Exp. Forest	381800	Y	Y	Y	Y
Santee NWR	420680	Y	Y	Y	Y
Walker Branch	440040	Y	Y	Y	Y
Giles County	441140	Y	Y	Y	Y
Elkmont	441190	Y	Y	Y	Y
Beeville	450350	Y	Y	Y	Y
Attwater Prairie Chicken	451060	Y	Y	N	Y
Longview	452180	Y	Y	Y	Y
Forest Seed Center	453800	Y	Y	Y	Y
Victoria	455350	Y	Y	Y	Y
Horton's Station	481300	Y	Y	N	Y
Big Meadows	482890	Y	Y	Y	Y
Sullivan Lake	491540	Y	Y	N	Y
Popple River	510960	Y	Y	Y	Y
Suring	512500	Y	Y	N	Y
Trout Lake	513640	Y	Y	N	Y
Lake Geneva	513680	Y	Y	N	Y
Spooner	513700	Y	Y	N	Y
Snowy Range-Glacier Lake	520020	Y	Y	Y	Y
Snowy Range - Nash Fork	520021	Y	Y	Y	Y

TABLE 10, PAGE 2. SYSTEM CHECKS OF FIELD LABORATORY

Site Name	ID	Report Forms Complete	Rain Charts Fully Annotated	Elapsed Time Sample Removal Until Shipment (days)
Sand Mountain	011020	Y	Y	2 days
Niwot Saddle	060220	Y	Y	1 day
Sugarloaf	060221	Y	Y	1 day
Buffalo Pass-Summit Lake	061920	Y	Y	1 day
Buffalo Pass - Dry Lake	061921	Y	Y	1 day
Engineer Mountain	061980	Y	Y	1 day
Molas Pass	061981	Y	Y	1 day
Bradford Forest	100360	Y	Y	3 days
Kennedy Space Center	100380	Y	Y	same day
Everglades National Park	101190	Y	Y	same day
Quincy	101400	Y	Y	same day
Verna Well Field	104100	Y	Y	same day
Bellville	112040	Y	Y	1 day
Georgia Station	114140	Y	Y	same day
Tifton ARS	115000	Y	Y	same day
Headquarters	130480	Y	Y	2 days
Reynolds Creek	131180	Y	Y	1 day
Shabbona	141800	Y	Y	1 day
Argonne	141980	Y	Y	1 day
Huntington Reservoir	152020	Y	Y	same day
Indiana Dunes	153420	Y	Y	1 day
Purdue	154100	Y	Y	1 day
Lilley Cornett Woods	182260	Y	Y	same day
Acadia National Park	200011	Y	Y	2 days
Caribou	200045	Y	^	2 days
Presque Isle	200046	Y	^	2 days
Bridgeton	200277	Y	Y	^
Greenville	200935	Y	Y	same day
Marcell Exp. Forest	241660	Y	Y	1 day
Fernberg	241840	Y	Y	same day
Camp Ripley	242360	^	Y	same day
Clinton	251080	Y	^	same day
Meridian	251460	Y	^	1-2 days
Coffeeville	253000	Y	^	2 days
Lewiston	340320	Y	Y	same day

TABLE 10, PAGE 2 (cont). SYSTEM CHECKS OF FIELD LABORATORY

Site Name	ID	Report Forms Complete	Rain Charts Fully Annotated	Elapsed Time Sample Removal Until Shipment (days)
Coweeta	342500	Y	Y	same day
Alsea Guard Station	380200	Y	Y	1-2 days
Hyslop Farm	380202	Y	Y	1-2 days
Bull Run	380260	Y	Y	1 day
Silver Lake	380980	Y	Y	same day
Andrews Exp. Forest	381020	Y	Y	same day
Vines Hill	381120	Y	Y	1 day
Starkey Exp. Forest	381800	Y	Y	1 day
Santee NWR	420680	Y	Y	same day
Walker Branch	440040	Y	Y	1 day
Giles County	441140	Y	Y	1-2 days
Elkmont	441190	Y	Y	1 day
Beeville	450350	Y	Y	1 day
Attwater Prairie Chicken	451060	Y	Y	1 day
Longview	452180	Y	Y	same day
Forest Seed Center	453800	Y	Y	1 day
Victoria	455350	Y	^	1 day
Horton's Station	481300	Y	Y	1 day
Big Meadows	482890	Y	Y	1 day
Sullivan Lake	491540	Y	Y	1 week
Popple River	510960	Y	Y	1 day
Suring	512500	Y	Y	1 day
Trout Lake	513640	Y	Y	1 day
Lake Geneva	513680	Y	Y	1 day
Spooner	513700	Y	Y	1 day
Snowy Range-Glacier Lake	520020	Y	Y	1 day
Snowy Range - Nash Fork	520021	Y	Y	1 day

laboratory practices. Field personnel were observed while making pH and conductivity measurements and adherence to technique was noted.

Tables 11 and 12 present the results of checks considered key to good pH and conductivity measurements, respectively. In general, specified procedures were adhered to and laboratory technique was good. Only two sites (3%) had a variance with pH measurement technique. Not all sites use the inverted cell technique for measuring conductivity. This is usually due to the fact that the site does not use the type of electrode that may be inverted.

Each site operator rinsed the conductivity cell with sample before taking the second reading. Only one site measured the standard, deionized water, and sample in the wrong order. NADP/NTN procedure requires the measurement of deionized water after the 75 μS/cm standard and before the precipitation sample to ensure there is no carry-over from the standard to the lower ionic strength rain sample. Proper analysis procedures were always discussed with site operators whenever the need was evident.

Results of Field Site Analysis of Simulated Precipitation

Each field laboratory was asked to analyze a performance audit solution for conductivity and pH. These solutions were prepared by dilution of EPA-supplied performance test solutions; the audit value is that designated by EPA and lies between pH 3.8 and 4.8, and has a conductivity between 20 and 77 μS/cm. Designated NADP/NTN network quality limits are $\pm$ 0.1 unit for pH and $\pm$ 4 μS/cm for conductivity. Table 13 summarizes the findings.

Ninety-seven percent of the 60 field laboratories checked had pH results within $\pm$ 0.1 unit of the designated value. The average absolute difference was 0.036 $\pm$ 0.03 pH unit. Of the two sites that exceeded the accuracy requirement, one had a faulty pH electrode and the other had a faulty meter. Two sites had inoperative pH electrodes and could not be tested. Ninety-seven percent of the field laboratories obtained conductivity values which varied by no more than $\pm$ 4 μS/cm from the designated value. The average absolute difference was 1.46 $\pm$ 1.34 μS/cm.

Balances are used at the sites to weigh the mass of precipitation collected by the Aerochem Metrics collector. They are usually mechanical triple-beam balances. The balances were checked with weights ranging from approximately 800 to 4000 grams.

TABLE 11. pH MEASUREMENT TECHNIQUES

Site Name	ID	Fill Hole Open	Distilled Water Rinses	Slope Adjust Used	Electrode Tip Protected
Sand Mountain	011020	Y	Y	Y	Y
Niwot Saddle	060220	^	^	^	^
Sugarloaf	060221	Y	Y	Y	Y
Buffalo Pass-Summit Lake	061920	Y	^	Y	Y
Buffalo Pass - Dry Lake	061921	Y	Y	Y	Y
Engineer Mountain	061980	Y	^	Y	Y
Molas Pass	061981	Y	Y	Y	Y
Bradford Forest	100360	Y	Y	Y	Y
Kennedy Space Center	100380	Y	Y	Y	Y
Everglades National Park	101190	Y	Y	Y	Y
Quincy	101400	Y	Y	Y	Y
Verna Well Field	104100	Y	Y	Y	Y
Bellville	112040	Y	Y	Y	Y
Georgia Station	114140	Y	Y	Y	Y
Tifton ARS	115000	Y	N	Y	Y
Headquarters	130480	Y	Y	Y	Y
Reynolds Creek	131180	Y	Y	Y	Y
Shabbona	141800	Y	Y	Y	Y
Argonne	141980	Y	Y	Y	Y
Huntington Reservoir	152020	Y	Y	Y	Y
Indiana Dunes	153420	Y	Y	Y	Y
Purdue	154100	Y	Y	Y	Y
Lilley Cornett Woods	182260	Y	Y	Y	Y
Acadia National Park	200011	Y	Y	Y	Y
Caribou	200045	Y	Y	Y	Y
Presque Isle	200046	Y	Y	Y	Y
Bridgeton	200277	Y	N	Y	Y
Greenville	200935	Y	Y	Y	Y
Marcell Exp. Forest	241660	Y	Y	Y	Y
Fernberg	241840	Y	Y	Y	Y
Camp Ripley	242360	Y	Y	Y	Y
Clinton	251080	Y	N	N	Y
Meridian	251460	Y	Y	Y	Y
Coffeeville	253000	Y	Y	N	Y
Lewiston	340320	Y	Y	Y	Y

TABLE 11 (cont). pH MEASUREMENT TECHNIQUES

Site Name	ID	Fill Hole Open	Distilled Water Rinses	Slope Adjust Used	Electrode Tip Protected
Coweeta	342500	Y	Y	Y	Y
Alsea Guard Station	380200	Y	Y	Y	Y
Hyslop Farm	380202	Y	Y	Y	Y
Bull Run	380260	Y	Y	Y	Y
Silver Lake	380980	Y	Y	Y	Y
Andrews Exp. Forest	381020	Y	Y	Y	Y
Vines Hill	381120	Y	Y	Y	Y
Starkey Exp. Forest	381800	Y	Y	Y	Y
Santee NWR	420680	Y	Y	Y	Y
Walker Branch	440040	Y	Y	Y	Y
Giles County	441140	Y	Y	Y	Y
Elkmont	441190	Y	Y	Y	Y
Beeville	450350	Y	Y	Y	Y
Attwater Prairie Chicken	451060	Y	Y	Y	Y
Longview	452180	Y	Y	Y	Y
Forest Seed Center	453800	Y	Y	Y	Y
Victoria	455350	Y	Y	Y	Y
Horton's Station	481300	Y	Y	Y	Y
Big Meadows	482890	Y	Y	Y	Y
Sullivan Lake	491540	Y	Y	Y	Y
Popple River	510960	Y	Y	Y	Y
Suring	512500	Y	Y	Y	Y
Trout Lake	513640	Y	Y	Y	Y
Lake Geneva	513680	Y	Y	Y	Y
Spooner	513700	Y	Y	Y	Y
Snowy Range-Glacier Lake	520020	Y	^	Y	Y
Snowy Range - Nash Fork	520021	Y	Y	Y	Y

TABLE 12. CONDUCTIVITY MEASUREMENT TECHNIQUES

Site Name	ID	Inverted Cell Technique	Standard Tested Before H2O	Distilled Water Rinse	Sample Rinse	Conductivity Values Corrected
Sand Mountain	011020	N	Y	^	Y	Y
Niwot Saddle	060220	Y	Y	^	^	Y
Sugarloaf	060221	Y	Y	^	Y	Y
Buffalo Pass-Summit Lake	061920	Y	Y	^	^	Y
Buffalo Pass - Dry Lake	061921	Y	Y	^	Y	Y
Engineer Mountain	061980	Y	Y	^	^	Y
Molas Pass	061981	Y	Y	^	Y	Y
Bradford Forest	100360	Y	Y	^	Y	Y
Kennedy Space Center	100380	Y	Y	^	Y	Y
Everglades National Park	101190	Y	Y	^	Y	Y
Quincy	101400	N	Y	^	Y	Y
Verna Well Field	104100	Y	N	^	Y	Y
Bellville	112040	Y	Y	^	Y	Y
Georgia Station	114140	N	Y	^	Y	Y
Tifton ARS	115000	N	Y	^	Y	Y
Headquarters	130480	Y	Y	^	Y	Y
Reynolds Creek	131180	Y	Y	^	Y	Y
Shabbona	141800	Y	Y	^	Y	Y
Argonne	141980	N	Y	^	Y	Y
Huntington Reservoir	152020	Y	Y	^	Y	Y
Indiana Dunes	153420	Y	Y	^	Y	Y
Purdue	154100	Y	Y	^	Y	Y
Lilley Cornett Woods	182260	Y	Y	^	Y	Y
Acadia National Park	200011	Y	Y	^	Y	Y
Caribou	200045	Y	Y	^	Y	Y
Presque Isle	200046	Y	Y	^	Y	Y
Bridgeton	200277	N	Y	^	Y	Y
Greenville	200935	Y	Y	^	Y	Y
Marcell Exp. Forest	241660	Y	Y	^	Y	Y
Fernberg	241840	Y	Y	^	Y	Y
Camp Ripley	242360	Y	Y	^	Y	Y
Clinton	251080	Y	Y	^	Y	Y
Meridian	251460	Y	Y	^	Y	Y
Coffeeville	253000	Y	Y	^	Y	Y
Lewiston	340320	N	Y	^	Y	Y

TABLE 12 (cont). CONDUCTIVITY MEASUREMENT TECHNIQUES

Site Name	ID	Inverted Cell Technique	Standard Tested Before H2O	Distilled Water Rinse	Sample Rinse	Conductivity Values Corrected
Coweeta	342500	Y	Y	^	Y	Y
Alsea Guard Station	380200	N	Y	^	Y	Y
Hyslop Farm	380202	N	Y	^	Y	Y
Bull Run	380260	N	Y	^	Y	Y
Silver Lake	380980	Y	Y	^	Y	Y
Andrews Exp. Forest	381020	N	Y	^	Y	Y
Vines Hill	381120	Y	Y	^	Y	Y
Starkey Exp. Forest	381800	Y	Y	^	Y	Y
Santee NWR	420680	N	Y	^	Y	Y
Walker Branch	440040	Y	Y	^	Y	Y
Giles County	441140	N	Y	^	Y	Y
Elkmont	441190	Y	Y	^	Y	Y
Beeville	450350	Y	Y	^	Y	Y
Attwater Prairie Chicken	451060	N	Y	^	Y	Y
Longview	452180	N	Y	^	Y	Y
Forest Seed Center	453800	Y	Y	^	Y	Y
Victoria	455350	Y	Y	^	Y	Y
Horton's Station	481300	Y	Y	^	Y	Y
Big Meadows	482890	Y	Y	^	Y	Y
Sullivan Lake	491540	Y	Y	^	Y	Y
Popple River	510960	Y	Y	^	Y	Y
Suring	512500	Y	Y	^	Y	Y
Trout Lake	513640	Y	Y	^	Y	Y
Lake Geneva	513680	Y	Y	^	Y	Y
Spooner	513700	Y	Y	^	Y	Y
Snowy Range-Glacier Lake	520020	N	Y	^	^	Y
Snowy Range - Nash Fork	520021	N	Y	^	Y	Y

TABLE 13. RESULTS OF FIELD SITE ANALYSIS OF SIMULATED PRECIPITATION

	pH (pH units)			Conductivity (uS/cm)			
Site Name	Site	Audit	Diff*	DI H2O	Site	Audit	Diff*
Sand Mountain	4.40	4.39	0.01	2.4	20.1	20.2	-0.10
Niwot Saddle	3.82	3.80	0.02	1.6	78.3	77.1	1.20
Sugarloaf	3.82	3.80	0.02	1.6	78.3	77.1	1.20
Buffalo Pass-Summit Lake	3.82	3.80	0.02	1.6	79.1	77.1	2.00
Buffalo Pass - Dry Lake	3.82	3.80	0.02	1.6	79.1	77.1	2.00
Engineer Mountain	3.81	3.80	0.01	2.9	80.7	77.1	3.60
Molas Pass	3.81	3.80	0.01	2.9	80.7	77.1	3.60
Bradford Forest	4.39	4.39	0.00	0.7	20.7	20.2	0.50
Kennedy Space Center	4.33	4.39	-0.06	1.1	18.7	20.2	-1.50
Everglades National Park	4.37	4.39	-0.02	2.8	19.4	20.2	-0.80
Quincy	4.43	4.39	0.04	1.5	20.9	20.2	0.70
Verna Well Field	4.33	4.39	-0.06	1.5	22.3	20.2	2.10
Bellville	4.37	4.39	-0.02	2.2	23.8	20.2	3.60
Georgia Station	4.39	4.39	0.00	1.0	21.6	20.2	1.40
Tifton ARS	4.40	4.39	0.01	14.4	20.6	20.2	0.40
Headquarters	4.29	4.31	-0.02	2.0	24.6	24.1	0.50
Reynolds Creek	4.34	4.31	0.03	1.2	21.7	24.1	-2.40
Shabbona	4.39	4.39	0.00	4.2	23.4	20.2	3.20
Argonne	4.45	4.39	0.06	1.4	20.3	20.2	0.10
Huntington Reservoir	4.31	4.39	-0.08	2.4	20.6	20.2	0.40
Indiana Dunes	4.41	4.39	0.02	1.9	21.9	20.2	1.70
Purdue	4.36	4.39	-0.03	1.4	21.1	20.2	0.90
Lilley Cornett Woods	4.38	4.39	-0.01	4.7	22.2	20.2	2.00
Acadia National Park	3.83	3.80	0.03	2.7	73.8	77.1	-3.30
Caribou	^	3.80	^	2.6	70.5	77.1	-6.60
Presque Isle	3.79	3.80	-0.01	2.1	81.7	77.1	4.60
Bridgeton	3.72	3.80	-0.08	6.3	73.1	77.1	-4.00
Greenville	3.89	3.80	0.09	1.2	75.1	77.1	-2.00
Marcell Exp. Forest	3.82	3.80	0.02	0.6	76.3	77.1	-0.80
Fernberg	3.83	3.80	0.03	1.7	76.0	77.1	-1.10
Camp Ripley	3.80	3.80	0.00	1.2	77.0	77.1	-0.10
Clinton	4.51	4.39	0.12	1.5	20.8	20.2	0.60
Meridian	4.35	4.39	-0.04	2.6	19.8	20.2	-0.40
Coffeeville	4.34	4.39	-0.05	3.4	22.8	20.2	2.60
Lewiston	4.38	4.39	-0.01	2.4	20.5	20.2	0.30

* Difference = Site Value - Audit Value

TABLE 13 (cont). RESULTS OF FIELD SITE ANALYSIS OF SIMULATED PRECIPITATION

Site Name	pH (pH units)			Conductivity (uS/cm)			
	Site	Audit	Diff*	DI H2O	Site	Audit	Diff*
Coweeta	4.31	4.39	-0.08	3.0	20.5	20.2	0.30
Alsea Guard Station	4.37	4.39	-0.02	1.2	20.5	20.2	0.30
Hyslop Farm	4.37	4.39	-0.02	1.2	20.5	20.2	0.30
Bull Run	4.34	4.39	-0.05	2.2	21.3	20.2	1.10
Silver Lake	4.38	4.39	-0.01	2.3	21.3	20.2	1.10
Andrews Exp. Forest	4.29	4.39	-0.10	1.2	20.5	20.2	0.30
Vines Hill	4.36	4.31	0.05	1.7	24.1	24.1	0.00
Starkey Exp. Forest	4.38	4.31	0.07	1.3	23.7	24.1	-0.40
Santee NWR	4.35	4.39	-0.04	0.9	21.2	20.2	1.00
Walker Branch	4.38	4.39	-0.01	0.7	22.1	20.2	1.90
Giles County	4.43	4.39	0.04	1.8	19.6	20.2	-0.60
Elkmont	4.26	4.39	-0.13	1.3	21.6	20.2	1.40
Beeville	4.39	4.39	0.00	2.7	21.6	20.2	1.40
Attwater Prairie Chicken	4.42	4.39	0.03	4.5	20.5	20.2	0.30
Longview	4.34	4.39	-0.05	1.8	21.8	20.2	1.60
Forest Seed Center	4.31	4.39	-0.08	1.4	20.3	20.2	0.10
Victoria	4.37	4.39	-0.02	7.8	20.6	20.2	0.40
Horton's Station	4.44	4.39	0.05	1.4	17.8	20.2	-2.40
Big Meadows	^	4.39	^	1.8	21.6	20.2	1.40
Sullivan Lake	4.33	4.31	0.02	1.5	25.9	24.1	1.80
Popple River	3.80	3.80	0.00	2.1	77.0	77.1	-0.10
Suring	3.83	3.80	0.03	2.0	80.5	77.1	3.40
Trout Lake	3.83	3.80	0.03	0.5	76.5	77.1	-0.60
Lake Geneva	3.85	3.80	0.05	1.4	80.7	77.1	3.60
Spooner	4.79	4.80	-0.01	2.2	78.1	77.1	1.00
Snowy Range-Glacier Lake	3.86	3.80	0.06	1.1	77.8	77.1	0.70
Snowy Range - Nash Fork	3.86	3.80	0.06	1.1	77.8	77.1	0.70

* Difference = Site Value - Audit Value

Only three of 58 sites checked had errors of greater than 5 grams over the range of test weights. The worst case was a +10.9 g disagreement at a loading of 3292 g. This was discovered to be due to binding of the beam arm dampening attachment in the mechanism of the magnetic damper. This was corrected and the disagreement was only 4.4 g.

Of fifty-eight balances checked, the absolute average of the worst case differences was 2.2 g. This usually occurred at the maximum load applied and corresponded to less than 0.1 percent of the average load of 3736 g, or less than 0.002 inch of rain (where 1724 grams = 1 inch of rain for the Aerochem Metrics collector).

SECTION 7
COMPARISON OF 1987 AND 1985-1986 SITE VISITATION RESULTS

In order to assess improvements in network siting and operations, results from selected categories from visits to 56 NADP/NTN sites made in the second round (1987) of the site visitation program were compared to results for the same categories for the same sites from the first round (1985-1986). (Note that six new sites were visited in 1987 that were not on-line during the first round of visits.) Results from the following categories are compared: supervisory and operator personnel, siting criteria, performance of the Aerochem Metrics collector and Belfort rain gauge, and results of field determinations of pH and conductivity. These are discussed below.

SITE SUPERVISOR AND OPERATOR CHANGES

It was noted that nineteen of fifty-six (34%) supervisors had changed between the two visits. Also, 28 of fifty-six (50%) operators had changed. Several of the operators had become supervisors, so continuity was not lost in these instances.

SITING CRITERIA COMPARISONS

Table 14 lists three siting criteria relating to precipitation collector placement and six criteria relating to site surroundings. In almost every case, there was an improvement in the number of sites meeting the criteria. For instance, in the first round, collectors at 20 sites did not have the wet bucket oriented towards the west; in the second round only 12 were incorrectly oriented. The last column of Table 14 compares the number of sites that were nonstandard during the first round to the number of these same sites that were found to still be noncompliant at the time of the second round visit. For example, of seven sites that, in Round 1, had vegetation growing to two feet or greater height within 30 m of the collector, only three of these seven were in the same condition at the time of the second visit. However, Table 14 indicates that a total of 12 sites visited in Round 2 had vegetative growth of height greater than two feet. Thus, nine sites that met this criterion in Round 1 did not do so in Round 2.

TABLE 14. COMPARISON OF RESULTS OF SITING CRITERIA: ROUND 1 AND ROUND 2 VISITS

Siting Criteria	Number and Percent Not Meeting Criteria		Nonstandard Sites
	Round 1	Round 2	Round 1[a] / Round 2
Collector Location			
• Wet bucket orientation	20 (36%)	12 (23%)	20 / 11
• Collector-gauge separation	17 (30%)	11 (18%)	17 / 9
• Collector-gauge heights	6 (11%)	7 (13%)	6 / 3
Site Surroundings			
• Vegetation greater than 2 feet in height within 30 m	7 (12.5%)	12 (21%)	7 / 3
• 45° angle violation from tree or obstruction	8 (14%)	6 (10%)	8 / 5
• Storage or parking lots < 100 m	14 (25%)	10 (16%)	14 / 5
• Animals < 30 m	5 (9%)	4 (6%)	5 / 2
• Feedlots < 500 m	3 (5%)	0 (0%)	3 / 0
• Transit sources < 100 m	8 (14%)	6 (10%)	8 / 4

[a] Includes only those 56 sites visited in Round 2 that were active during the time of Round 1 visits.

COLLECTOR AND RAIN GAUGE COMPARISONS

Aerochem Metrics Precipitation Collector

Six installation and operation criteria for the Aerochem Metrics collector were compared. Table 15 summarizes the findings. Five of the 56 collectors were not level at the time of the Round 1 visits. Five were not level during Round 2 visits. Of the original five, three had been leveled. This means three additional sites became unlevel in the time between visits. Another category is clutch wear, indicated in its first stages by a shiny clutch surface or, more dramatically, by a hollowed-out indented space. Seven were noted to have clutch wear at the time of the Round 1 visits; eleven in Round 2. However, six of the seven clutches originally noted to be wearing in Round 1 had either been repaired or conditions had changed to halt the wear. This means that corrective action steps are being taken but that clutch wear is a continuing problem, as it was noted at 10 additional sites in Round 2. This could be an indication of normal wear patterns as the network's equipment becomes older.

The most dramatic improvement in criteria satisfaction was with sensor performance (heating, etc.). Of the 12 that performed improperly at the time of Round 1, all operated properly in Round 2. Sensors at only two additional sites were found to be malfunctioning.

Belfort Rain Gauge

Two items were compared concerning the rain gauge. Was the gauge level, and did it require calibration by the site visitor? Table 15 lists the data. Four of fifty-six collectors were found to be out-of-level at the time of the Round 1 visits. Of these four, three had been leveled. In Round 2, four more of the original 56 were judged to be out-of-level.

Twenty of fifty-six gauges required calibration during Round 1 visits. Nineteen of these same 56 required calibration during Round 2. It is interesting to note that 14 of the 20 gauges calibrated in Round 1 did not require calibration during Round 2. Twenty gauges were found to be in calibration over the full 12-inch range during Round 1 visits. Of these twenty, 16 still met calibration specifications at the time of Round 2 visits, approximately two years later.

TABLE 15. COMPARISON OF AEROCHEM METRICS COLLECTOR AND BELFORT RAIN GAUGE INSTALLATION AND PERFORMANCE: ROUND 1 AND ROUND 2 VISITS

Criteria	Number and Percent Not Meeting Criteria[a]		Nonstandard Sites
	Round 1	Round 2	Round 1 / Round 2
Aerochem Metrics Collector			
• Collector level	5 (9%)	5 (9%)	5 / 2
• Collector stable	1 (2%)	0 (0%)	1 / 0
• Correct counterweight	3 (7%)	2 (4%)	3 / 1
• Clutch wear	7 (13%)	11 (20%)	7 / 1
• No gaps, bucket to lid seal	1 (2%)	0 (0%)	1 / 0
• Sensor performance	12 (22%)	2 (3%)	12 / 0
Belfort Rain Gauge			
• Gauge level	4 (7%)	5 (9%)	4 / 1
• Gauge required calibration by RTI	20 (36%)	19 (34%)	20 / 6

[a] Of 56 collectors that were in operation at the time of both Round 1 and Round 2 visits.

CONDUCTIVITY AND pH MEASUREMENT COMPARISON

The fifty-six sites were compared for accuracy of measurement of conductivity and pH. An improvement was noted in the number of sites that are able to determine the conductivity of a simulated precipitation sample to within $\pm$ 4 μS/cm and pH to within $\pm$ 0.1 pH unit of the designated value. Of the six sites that were out-of-tolerance on conductivity measurements in Round 1, none repeat in Round 2. Of the twelve sites out-of-tolerance in measuring pH, none repeat in Round 2.

SECTION 8
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